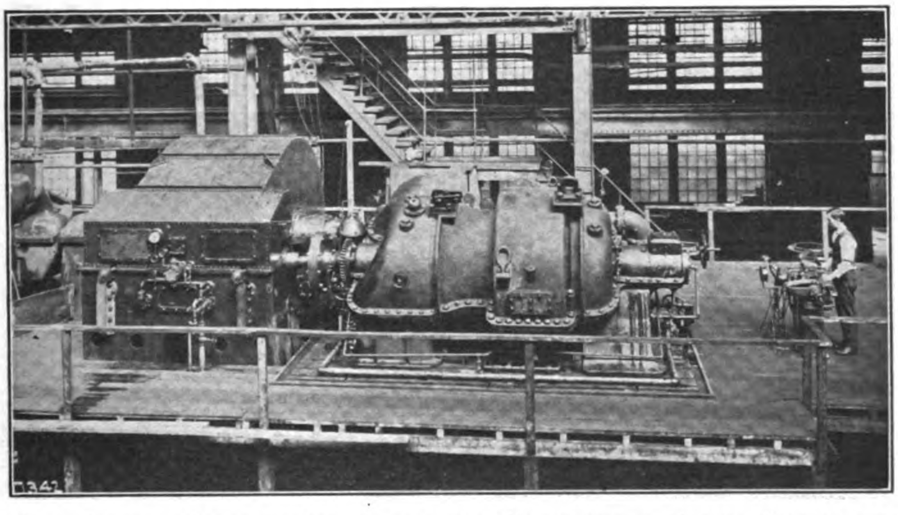
THE MARINE REVIEW

VOL. 41 CLEVELAND JUNE, 1911 NEW YORK No. 6

TURBINES AND REDUCTION GEAR FOR COLLIER NEPTUNE

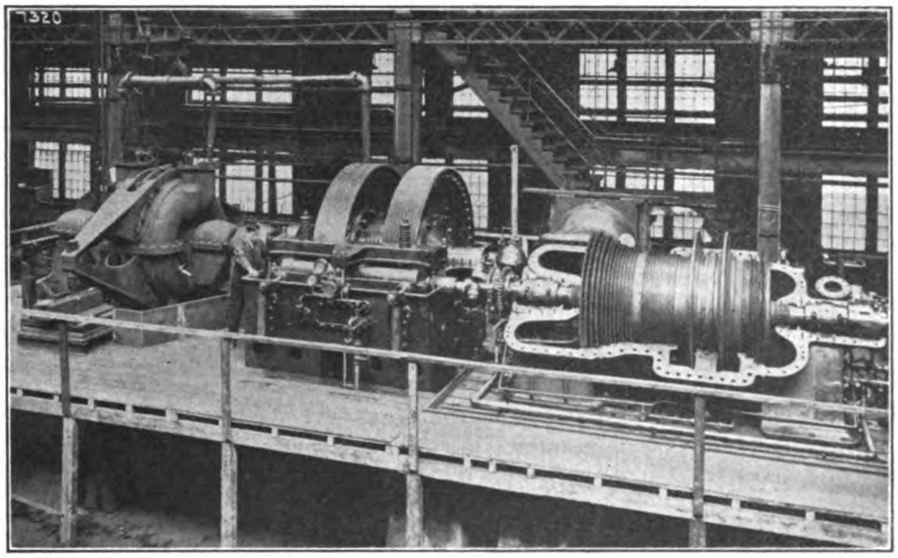
TWO marine turbines and reduction gears have been finished and one has been shipped by the Westinghouse Machine Co., and is now being installed upon U. S. collier Neptune, a ship of about 19,000 tons. The second outfit was shipped May 13 and put in place in order to permit of official trials of the Neptune in June. These tests are regarded by naval men as of the highest importance because of the use of comparatively small turbines and reduction gears interposed between their shafts and the propeller shafts, it being claimed that the weight of this class of machinery will be less than half of the weight of other turbines having the propellers coupled direct to the turbine shafts or of reciprocating engines, and that, by reason of the higher speed, the turbines used with reduction gears will require, especially for cruising speeds, from 20 to 30 per cent less steam than is now needed by any of the turbine driven ships or ships driven by reciprocating engines.



View Showing Complete Assembly of the Westinghouse Marine Turbine and Reduction Gear, Man Standing at Operating Platform Having His Left Hand on the Operating Lever Which Controls the Turbine

The design of the turbines adopted has an ahead portion and a reverse portion, and a cruising element, all within one casing. The control mechanism is of an exceedingly simple character and is so arranged that each engine may be run in either direction at any speed up to the maximum, either by mechanism operated in the engine-room or by a duplicate operated from the bridge of the ship, the latter feature being of high importance in the maneuvering of a ship. In fact, the man on the bridge can reverse either or both turbines from full speed ahead to full speed astern in less than 15 seconds, or in much less time than it now takes to communicate signals from the bridge to the engine-room with other types of control. The speed and direction of both turbines being under instant control, permits of the turning of the ship in the shortest possible distance, and in the event of the steering apparatus being disabled, the ship can be steered and kept to its course by the manipulation of the speed of the turbines. The overspeeding of the turbine engines from any cause whatever, and especially in a heavy sea, is automatically prevented by the governor control. All steam and exhaust connections are made to the lower half of the turbine and the general construction is such that the steam may be turned directly into the apparatus when cold and full speed attained in less than a minute; whereas, the form and dimensions of the turbines which have heretofore been used for naval service have been such that the turbines required pre-heating before starting, such pre-heating taking from three to ten hours, according to the size of the machinery.

The upper half of the turbine is arranged so that it can be quickly thrown back upon its hinges in order that all of the blading of the turbine may be quickly inspected. To illustrate the value of this feature to Admirals Betbeder and Garcia of the Argentine navy and Admiral Cone, chief engineer of the United States navy, who recently visited Pittsburg for a critical inspection of the apparatus, the top cover of the turbine was loosened, removed from its place, the rotor containing the blades given a complete revolution by hand, and the cover restored to its place and the engine again started, all in less than one hour,—to be exact, in fifty minutes; this in contrast with several days required to open up and similarly inspect the turbines for one of the screws of a modern battleship.



VIEW OF THE WESTINGHOUSE MARINE TURBINE AND REDUCTION GEAR WITH UPPER CASING OF TURBINE AND REDUCTION GEAR REMOVED. THE BRAKE IS SHOWN AT THE EXTREME LEFT

The reduction gearing has a floating frame for maintaining uniform tooth pressure, but the means for floating the pinion frame is of a novel character and not only provides for an elastic motion and a separation of metallic connection between the casing of the pinion and the main casing (which reduces vibration), but at the same time provides an hydraulic dynamometer whereby the exact propeller shaft horsepower being delivered by a turbine, can be read from a gage. This dynamometer arrangement is mathematically and practically correct and will give advantages in the running of steamships of the very highest importance.

The United States government has already applied a number of Parsons and Curtis turbines for the propulsion of war vessels, and after prolonged tests, the general board reached a conclusion, which it recently promulgated publicly that no further battleships would be fitted with turbine machinery of the kind that they have so far experimented with. The controlling reason for this decision is the large amount of steam and coal required to propel these ships at cruising speeds with turbines, as compared with reciprocating engines.

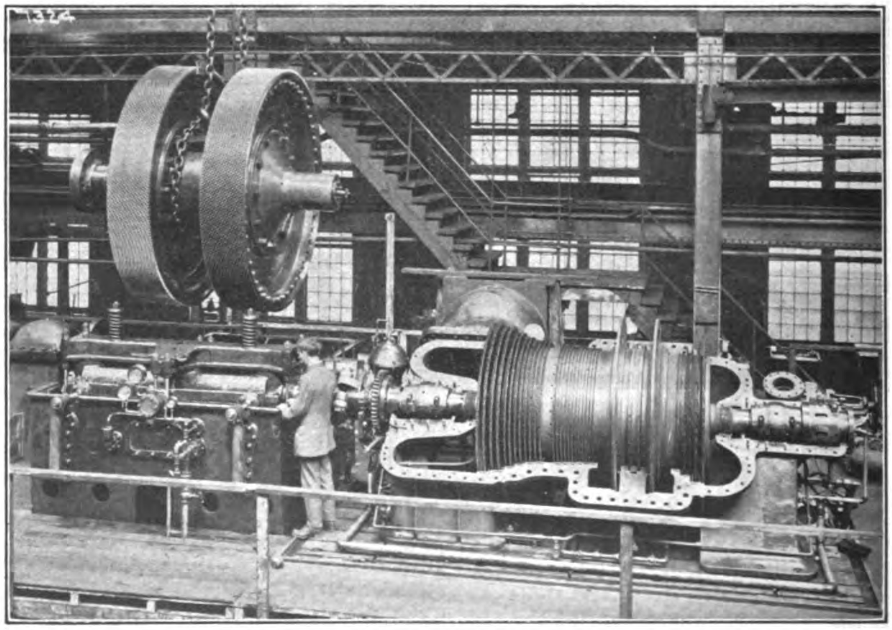
A demonstration by a trial on the Neptune of the practicability of reduction gearing for large horsepowers will, it is believed, change the entire situation with reference to the application of power to naval vessels. The saving of over one-half of the weight in engines and a decrease in the capacity of boilers required because of a less consumption of steam is of the highest importance, as it permits of the use of thicker armor and heavier guns.

The turbine and gear equipment being installed upon the Neptune represents over fifty years of study and experimentation under the direction of Mr. Westinghouse in the works of the Westinghouse Machine Co in the development of turbine machinery for the propulsion of ships. The departures from previous practice, which are radical, have been made in the interest of lessening the cost of construction, facilitating the operation of the machinery and its inspection, and in the reduction of the weight and space occupied, as well as in providing a control mechanism whereby the officer in charge of the ship may, without the intervention of any other person, have as complete a control of the engines as he now has of the steering apparatus.

Continental Iron Works

The *Brooklyn Eagle* recently issued an industrial edition, paying particular attention to the Continental Iron Works, one of the oldest and best known of the industries of Brooklyn. The sketch follows:

The Continental Iron Works, located on the East River front in the Greenpoint section of the Borough of Brooklyn, is one of the largest and oldest iron working concerns in this vicinity,



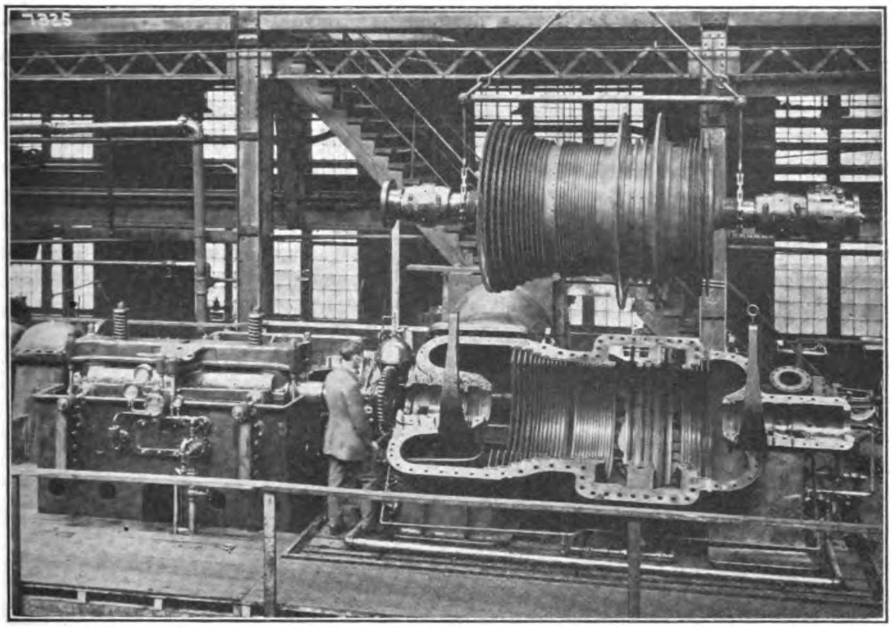
VIEW OF WESTINGHOUSE MARINE TURBINE AND REDUCTION GEAR WITH THE REDUCTION GEAR REMOVED FROM THE REDUCTION GEAR CASING. THE TURBINE IS SHOWN WITH THE COVER REMOVED AND ROTOR IN PLACE

having been established in 1859 and incorporated in 1887.

It was originally engaged principally in the construction of wooden vessels, including many of the noted side-wheel passenger steamers which plied upon Long Island Sound. Its activities were not entirely confined to wooden vessels, as several vessels of iron were constructed here, as well as various other iron structures, notably the first wrought iron pipe across High Bridge, over the Harlem river, for conveying Croton water to New York City.

Soon after the outbreak of the Civil War a contract was entered into for the construction of the hull of the original Ericsson Monitor. This work was so vigorously prosecuted that the vessel was launched in 100 days after the contract was signed, which enabled her to be fitted out at the Brooklyn navy yard and reach Hampton Roads in time to meet the Confederate vessel Merrimac and defeat her in that celebrated conflict. Upon the successful outcome of this battle, the navy department authorized the construction of a considerable number of vessels of the Monitor type, six or eight of which were constructed at these works.

Upon the decline of shipbuilding in and about New York City, the Continental Iron Works turned its attention to the construction of gas holders and gas producing plants for city illumination, and constructed many of the gas works in New York City and Brooklyn, and also in several of the largest cities of the eastern states, including Boston, Providence, Worcester and many of the smaller towns.



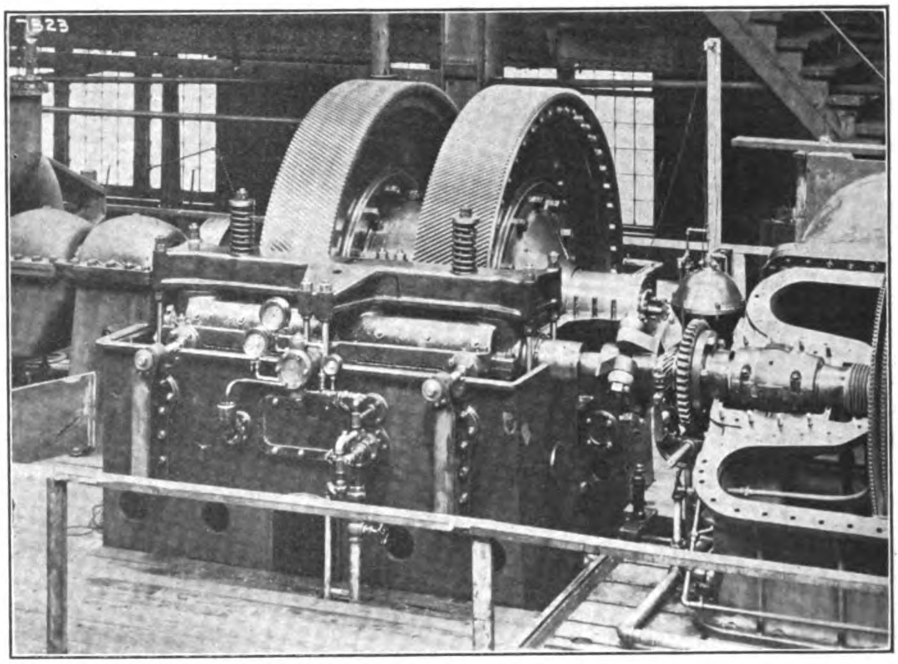
VIEW OF THE WESTINGHOUSE MARINE TURBINE AND REDUCTION GEAR CASING WITH PINION IN PLACE, THE GEAR BEING REMOVED FROM THE GEAR CASE AND THE TURBINE SPINDLE REMOVED FROM THE TURBINE CYLINDER, AS SHOWN BY THE PHOTOGRAPH.

In recent years the attention of the Continental Iron Works has been devoted to the more advanced lines of engineering activity, having directed its energies largely toward developing the process of producing steel structures with welded intsead of riveted joints, which has rendered possible the production of the well known corrugated furnace, used in marine boilers, and also in boilers for land purposes. This company is largely engaged in this particular line of work, having facilities for its production which are unsurpassed.

This method of construction is employed by this company in the production of digesters for making wood pulp, used in the manufacture of paper, some of which weigh from 20 to 25 tons, and are constructed without the use of any rivets whatever.

The same methods are used in the construction of gas-lighted buoys, employed by the United States Lighthouse Department for marking the channels in harbors, and for indicating the location of obstructions to navigation.

In recent years the demand for pipe of large size for conveying water at considerable pressure has opened a wide field for welded pipe, as its smooth interior surface reduces the friction of the water passing through it, rendering the pipe more efficient, and, at the same time, avoiding all leakage. The Continental Iron Works has made large quantities of pipe of this character, some of it being nearly 5 ft. in diameter, for use in connection with hydro-electric installations in Mexico and in Alaska. Because of the freedom from leakage and also the reduction of weight, secured by the adoption of welded joints, they have been employed in the construction of tanks and vessels of various description for use in chemical operations, for receivers for holding gases under high pressure, for the steam and water drums of torpedo boat boilers, and for almost innumerable purposes where absolute tightness is required.



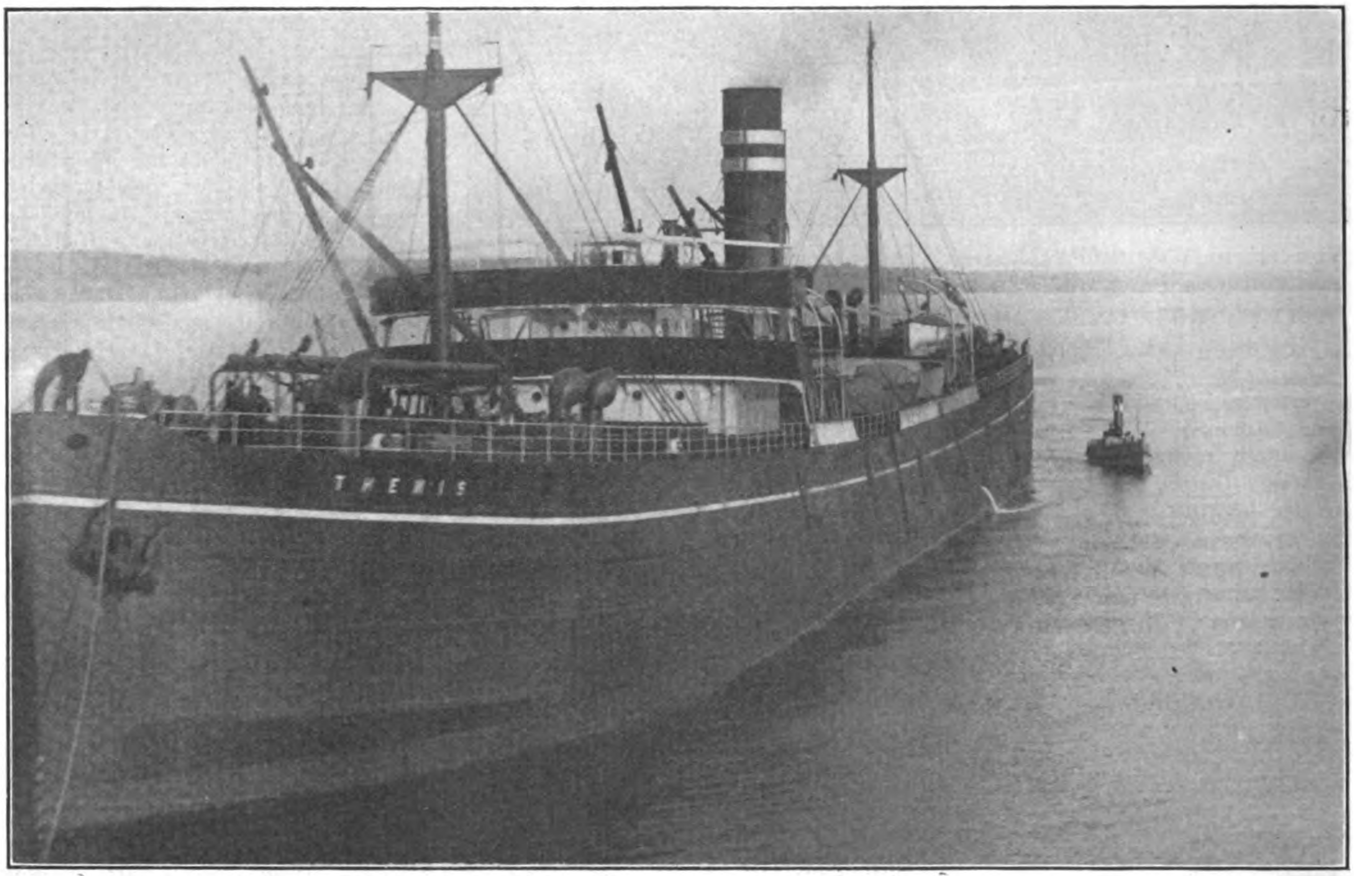
VIEW OF END OF THE WESTINGHOUSE MARINE TURBINE AND REDUCTION GEAR, SHOWING COVER OF REDUCTION GEAR REMOVED, THE BIG GEAR BEING SHOWN IN THE BACKGROUND, THE TORSION DYNAMOMETERS BEING INDICATED BY GAGES ON THE FRONT OF THE REDUCTION GEAR CASING

Transportation of Wabana Ore

IRON ore transportation in greater bulk between the Wabana, Newfoundland, mines and the United States, has been made possible by the recent addition to this service of two new steel steamships, the Tellus and the Themis. These boats are owned by Norwegian interests, which have taken an active part in the Canadian ore trade, and were only recently completed at the yards of Wm. Doxford & Sons, Sunderland, England. They were designed especially to fill the service of transporting iron ore between Newfoundland and this country, and were built to plans and specifications of the Nova Scotia Steel & Coal Co., Ltd., North Sydney, N. S., the operator of those Wabana mines which supply a good portion of the mixtures of a number of blast furnaces located along the eastern border of the United States. Occasionally the boats will make trans-Atlantic deliveries of ore, as, because of their large size, practically but three trips monthly to Philadelphia will be required to bring in the regular consignments of ore to eastern consumers. Under the present movement, these shipments are about 35,000 tons monthly. Both ships have been engaged by the Nova Scotia Steel & Coal Co. under 10-year charters.

The two vessels are identical and are 465 ft. long, 60 ft. beam and 37 ft. 6 in. molded depth. Their dead weight capacity is 12,925 tons. There are four holds of different length, No. 1 being 67 ft.; No. 2, 139 ft.; No. 3, 65 ft., and No. 4, 76 ft. The hatchways extend 36 ft. both athwartship and fore and aft, enabling ready extraction of the ore from the holds. Unloading is done by derrick hoists, located over each hatchway. There are 11 hoists in all and they are operated by steam winches. The engine is of the triple-expansion type, supplied with steam from three Scotch boilers, 17 ft. 6 in. by 11 ft. 3 in. Water ballast is carried in side tanks as well as in the water bottom.

On her recent maiden trip in the Wabana ore traffic, the Tellus docked 12,193 tons at the Port Richmond Piers, of the Philadelphia & Reading railroad, Philadelphia, over which all of this ore is received. On her trip across the Atlantic to enter the carrying trade from North Sydney to Philadelphia, the Tellus brought in April 7, a cargo of 11,600 tons of Swedish ore from Narvik, Norway. The Themis made her maiden trip in May from Wabana to Philadelphia, with a rated cargo of 12,500 tons.



STEAMSHIP THEMIS AT NORTH SYDNEY

Why Not Discriminating Duty?

ADMIRAL FRANCIS T. BOWLES, IN *Scientific American.*

It has been officially estimated that citizens of the United States pay for the transportation of their over-sea commerce, including freight, passenger fares and mails, the sum of $229,100 000 annually. This estimate is on a low basis of freight, and it is believed that the actual amount paid is nearer $300,000,000. Practically the whole of this business is in the hands of foreigners, and this expenditure is paid to them and must be considered as an item against the United States in the balance of trade, on account of which we must export products of the United States in payment.

There is, therefore, entirely apart from the military value of sea power, a substantial economic reason why the United States should become a carrying nation. The experience of sixty years of free trade in ocean transportation has conclusively shown that it is not profitable to American capital under present conditions and requires protection or some form of government aid

or subsidy. A comprehensive system of such protection, which will admit of development of either cargo or mail steamers as the necessities of trade require, should include:

First: Mail compensation to steamers such as is provided and now authorized under the ocean mail act of 1891.

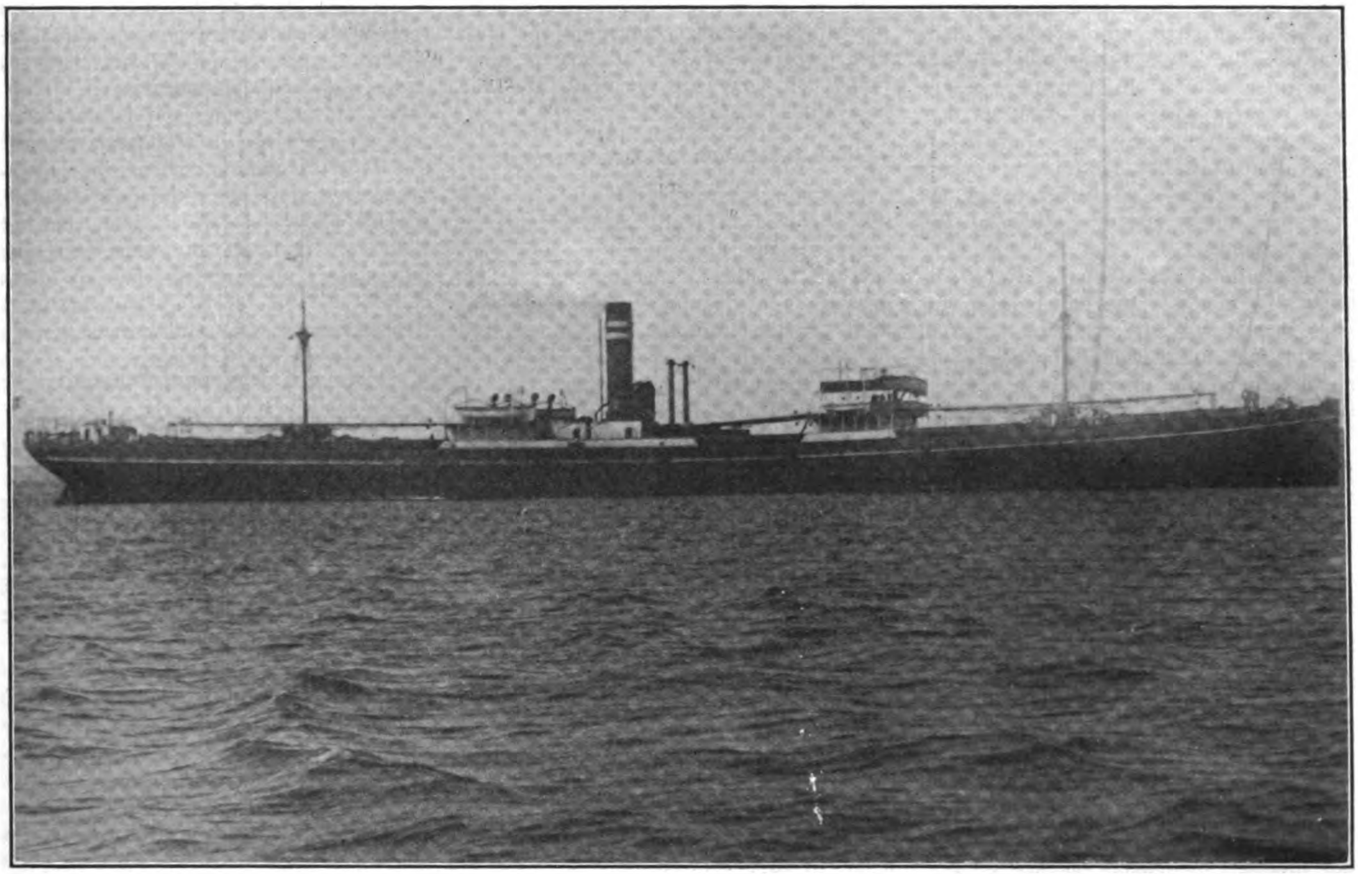
Second: Remission of the head tax of $4 on immigrants arriving in American vessels, which would be a substantial advantage to American mail steamers.

Third: A discriminating duty applicable to vessels of all types, but especially adapted to the development of cargo vessels under individual ownership. A method of applying a discriminating duty which would not disturb the free list, and would not appreciably affect the market value of imported merchandise or materials would be to enact a law providing that on all goods imported in American vessels on which the ad valorem duty exceeds 41 per cent, there would be a reduction of 5 per cent, and on all goods on which the ad valorem is 41 per cent or less, or which are non-dutiable, the importer should receive an importer's certificate available only for the payment of duties at the custom house, and equal in value to 2.05 per cent of the value of the goods so imported.

The average rate of duty under the present tariff is understood to be 41 per cent ad valorem, and 2.05 is 5 per cent of 41. These figures may not be exact, but they are intended to be sufficient to create a demand for American cargo boats in the foreign trade, by enabling the shipper to pay such vessels a higher rate of freight on homeward voyages, and enough higher to overcome the handicap of higher cost of vessels and operation under the American flag. They are probably sufficient for the purpose on all except some low-priced bulky cargoes. On outward voyages the American would be obliged to take the competitive rate. If, then, all our imports were carried in American vessels and half the goods were free or non-dutiable, this proposed law would be equivalent to a 10 per cent reduction in the tariff.

The total value of imports in the United States for the year ending July, 1910, was $1,562,000,000. If, under the operation of the laws proposed above, citizens of the United States should acquire the carrying of, say, $500,000,000 worth, or about one-third of this amount, in American vessels, it would probably be necessary to acquire under the American flag about 500 additional vessels, of various types, which might have the average tonnage of the foreign steam vessels entering our Atlantic ports, or about 3,000 gross tons. It would probably take 10 years to build these vessels at a cost of about $200,000,000, if built in the United States. They would employ on board about 40,00 men, and would be earning from $80,000,000 to $100,000,000 gross annually. The total cost for the annual charge on the United States at that time under the laws proposed would be approximately $10,000,000 a year, and during the 10 years in which this business was being acquired might have amounted to $50,000,000.

This, in a broad way, is the problem which we are considering in the acquisition of a merchant marine in the foreign trade. * * *



STEAMSHIP TELLUS AT NORTH SYDNEY.

Mauretania's Hundredth Trip

The Cunarder Mauretania recently completed her one-hundredth trip across the Atlantic. She went into commission three and a half years ago. During this time she has averaged 25¼ knots an hour and has covered 290,510 knots. Her fastest passage in this period was 4 days, 10 hours, and 41 minutes between Queenstown and New York. Her highest average speed is 27.04 knots per hour, and for a voyage 26.06. Her highest day's run westward was 676 knots, and eastward 614.

THE INTERNATIONAL COMBUSTION ENGINE FOR MARINE USE*

By C. F. Hirshfeld.†

THE recent announcement in the technical and popular press to the effect that the Hamburg-American Co. has ordered an 8,000-ton vessel to be propelled by internal combustion engines in two units of 1,500 horsepower each, has served to focus attention on one of the most vital and interesting problems of the day. Incidentally it is a problem which is, to a certain extent, much nearer satisfactory solution than is generally supposed and which offers large returns to the pioneers who have had the fortitude to persevere in the face of much adverse criticism and even scoffing.

Under the circumstances, it is pertinent to inquire into the reasons for the desirability of applying internal combustion to marine propulsion and to determine the present state of the art.

All engineering problems of this class are ultimately commercial problems and, other things being equal, that solution which, in the broadest sense, yields the largest return on the investment is the correct one. When viewed in this light, each engineering problem is worthy of independent study, in fact demands it. Because a certain solution has proved successful under a given set of conditions, there is no *a priori* reason for assuming that it is the correct one for all similar cases.

Should be Studied Separately.

For this reason, each application of the internal combustion engine to marine practice should be studied separately and investigators should refrain from sweeping conclusions and unwarrantedly broad statements. Ultimately, as the art develops, and as successes and failures are recorded, it will undoubtedly appear that internal combustion yields larger economic returns than external combustion with either reciprocating or turbine engines for certain classes of marine service. Just as in stationary practice, however, there will probably be many classes of service and many combinations of circumstances which call for the use of steam engines.

To a certain extent, the internal combustion principle has already proved its superiority in some types of craft. The small and medium sized pleasure boat, the power launch, the self-propelled canal boat or barge, the small passenger and freight boat, the fishing boat, the submarine and a number of others are all best operated with internal combustion engines, where suitable fuels are available.

In order to discuss the desirability of marine internal combustion, one must first form a clear idea of what a vessel really is, what its functions are and how these are related.

Considerations of Construction.

Excluding pleasure craft and war vessels, because in both cases commercial considerations are more or less subservient to others, a vessel may be regarded as a floating box or enclosure used for the transportation of material on water. In the case of any given vessel, the total weight which can be floated and the total bulk which can be contained, are limited.

The floated weight and the total bulk may each be divided into three distinct parts as follows:

(a) That of the vessel itself, that is all of the structural parts, such as frame, skin, decks, bulkheads, deck houses, etc.

(b) That of the propelling machinery, whether it be masts and sails, engines and boilers with the necessary fuel, water and oil for their operation; or what not. In each case the weight and bulk must include that of the complement of men necessary for operation and navigation with all that they make necessary in the way of living quarters and such, as well as that of all auxiliary machinery necessary for satisfactory operation and safety.

(c) That of the cargo, which is the part of the total transported weight or bulk, upon which the financial returns accruing from the operation of the vessel depend. This cargo may be assumed to consist of inanimate or animate commodities of any kind or even of human beings with their personal effects.

Question of Profit.

Obviously, with other things equal, that vessel, which can transport the greatest weight or bulk of cargo, as the case may be, should yield the largest returns on the original investment.

For vessels of similar character, similar speed, and designed for similar service, the weight of the structure itself may, without great error, be assumed independent of the type of motive power chosen. Therefore, increased cargo carrying capacity must come chiefly from diminution of weight, or diminution of bulk, or both, on the part of the propelling machinery.

We then come to the proposition that that form of motive power, which involves the least weight and bulk in main and auxiliary machinery, in fuel, water and oil supply, and in personnel, will, *if other things are equal*, promise the largest economic return. The modifying clause, "if other things are equal", should not, as is often done, be lost sight of; it is of the most sweeping importance and includes what are often apt to be the deciding factors in a choice between different motive powers.

Relative Safety and Reliability.

Thus the relative safety and reliability of different methods, flexibility of operation, kind and quality of fuel required, initial cost of installation, cost of upkeep, rate of depreciation of value because of new developments, etc., etc., must all come in for their share of consideration and are all included in the clause above referred to.

Excluding sails as a method of propulsion not pertinent, the first part of our problem then becomes a matter of determining under what, if any, conditions internal combustion may require less gross weight and bulk and a smaller crew than either reciprocating steam engines or steam turbines.

A second and no less important part must be a discussion of such things as safety, flexibility, etc., above mentioned, with the drawing of conclusions as to the extent, to which they may modify the results of the consideration outlined in the preceding paragraph.

The method of attack chosen is to first consider the peculiar conditions, under which marine machinery is operated and the peculiar requirements, which must be met, then to review in a brief way what has been done in the application of internal combustion to marine work, and lastly to consider the peculiar advantages and disadvantages possessed by such prime movers.

Having done this, we may attempt to draw conclusions with some hope of

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*Class lecture at Cornell University.

†Professor gas power engineering, Sibley College.

seeing them vindicated by subsequent events.

Requirements Which Marine Machinery Must Meet.

(a) The propelling and all auxiliary machinery, upon which its operation depends, must be as nearly capable of continued operation over definite time periods as human ingenuity can make it.

The reasons for this necessity are, first of all, that the continued existence of vessel and all aboard depend upon the ability of her engine crew to keep her engines turning over at a sufficiently rapid rate to make it possible to control the ship in any weather she may meet, and, second, that the largest return on the investment is to be expected when the engines can continuously maintain their normal speed, thus cutting to a minimum the time of transportation.

The time period for which continued operation must be assured is in the narrowest sense that required to travel from port to port with sufficient allowance for inclement weather. In a broader sense, the longer the time period the better, as this, on the one hand, implies slowly wearing parts, strength and rigidity of parts, successful lubrication, etc., and on the other, minimum time consumed in port in getting machinery ready for another trip.

Ability to Operate.

The principal things which assure continued ability to operate are:

(1) The choice of a method of operation, fuel, working fluid, cycle and such which permit the maximum amount of maladjustment, due to carelessness and inevitable wear without endangering the functioning of the mechanism.

(2) The subdivision of propelling and auxiliary machinery into as many independent units, and the subdivision of each unit into as many independent parts as is consistent with economy in first cost, cost of attendance, lubrication, weight and space, attachment to wheels or screws, etc.

(3) Correct design and choice of materials guided by the peculiar conditions existing aboard ship and the peculiar conditions characteristic of each type of prime mover.

(4) The minimum of small parts, the failure or wearing of which endanger continued operation. Such parts are adjusting wedges, latches, pin joints and such.

(5) Arrangements, whereby essential parts may be replaced during operation in so far as that is possible and whereby inevitable wear may be compensated for under the same conditions.

(b) The propelling and auxiliary machinery must be of such a character that it involves the minimum fire and explosion risk on the part of both its fuel and its working fluid, and further that in case of explosion or fire the least damage may be done to machinery, vessel and operating force.

Requirements Called For.

These considerations call for:

(1) The storage of all volatile fuels and of all fuels apt to liberate combustible gases in such fashion as to minimize the danger of the formation of explosive mixtures in enclosed, or partly enclosed and poorly ventilated, spaces or compartments.

(2) The division of bodies of heated water or similar material into the smallest economic parts to minimize the dangers accompanying rupture of containing vessels.

(3) The control of all burning fuel in such a way as to prevent its being widely spread outside of its regular containers by any such thing as an explosion.

(4) The elimination to as great an extent as possible of all pipes carrying high pressure, high temperature working fluids.

(5) The prevention of the formation of explosive mixtures in flues, pipes and such, which are not made of material heavy enough or so disposed as to be safe against explosion pressures.

(6) The absolute prohibition of the storage of explosive mixtures, at either atmospheric or higher pressures.

(c) The propelling and auxiliary machinery, inclusive of fuel and personnel, must have the minimum possible weight per unit of power delivered to the propelling device. Such light weight may be due to any of the following:

(1) Light weight of producer or preparer of working fluid and of its contents.

(2) Entire absence of such preparer aboard the vessel.

(3) Light weight of main engines.

(4) Light weight or entire absence of auxiliaries necessary for the continued operation of, or maneuvering with, main engines.

(5) High thermal economy of main and auxiliary machinery, thus reducing to a minimum the weight of fuel to be carried to insure a certain radius of action.

(6) The use of fuel, which combines high thermal content with minimum weight.

(7) Machinery of such character that a small force is required to operate it, thus reducing the weight of the crew and all that is necessary to make the life of the crew possible and convenient.

(d) The plant, inclusive of fuel and personnel, must occupy the minimum possible space per unit of power delivered to the propelling device. The remarks under (c) above apply equally well to this case with the word space or bulk substituted for weight throughout. To those should be added the following as worthy of note.

Concentration of Power.

(1) The concentration of power in large units tends toward economy of space.

(2) The adoption of plant requiring minimum head room tends to lower the center of gravity of the structure, which is very desirable and also may simplify the deck arrangement and construction.

(e) The propelling machinery should have its maximum efficiency at the rotative speed near that which is the most economical for the type of propelling device chosen in order that the combined efficiency of the outfit may approach a maximum.

(f) The tangential effort of the propelling machinery must be as even as possible, that is at all times as nearly as possible equal to the mean resistance at the crank pin.

(h) The distribution of weights and the relative motions of the reciprocating and rotating parts should be such that there is no great tendency toward vibration in a vertical or transverse direction and such that there is little tendency to tip in a vertical plane through the shaft. Further than this all vibrations set up must be of different period from that natural to the hull, including harmonics.

Obtaining Desirable Qualities.

These desirable qualities may be obtained by:

(1) The opposition of the inertia and centrifugal effects of the parts connected with one cylinder by those of one or more other cylinders.

(2) The opposition of tipping moments, due to one set of cylinders by equal but oppositely directed tipping moments of another set of cylinders.

(3) The choice of engine speed at such a value as to prevent coincidence of periods of vibration.

(h) The propelling and auxiliary machinery must adapt itself perfectly to the requirements of successful maneuvering. These call for:

(1) The ability to start quickly and surely under load with a minimum amount of preparation even after standing for long periods.

(2) The ability to run for long periods of time at any speed between a very low one and normal.

(3) The ability to reverse direction of rotation quickly and surely and to continue rotation in this reversed direction at any speed from low to normal with certainty and without time limit.

(i) The type of plant should be such as to radiate the smallest possible amount of heat in order to put least drain upon physical endurance of attendants. It should be noted that the amount of heat radiated must be considered in a relative and not an absolute sense, as a plant radiating an amount absolutely smaller than another, but at the same time occupying a smaller space might lead to higher operating temperatures than the less efficient outfit.

(j) The type of plant should be such as to involve a minimum first cost and a minimum maintenance and operating cost. Minimum values in these respects come from such things as:

(1) The choice of a type of plant which can be supplied by the maximum number of manufacturers.

(2) The choice of a type of plant involving the minimum amount of experiment in design, construction and operation.

(3) The choice of a plant capable of utilizing the cheaper forms of fuel.

(4) The choice of a plant requiring minimum attendance.

(5) The choice of a plant requiring the minimum quantity of lubricant.

(6) The choice of a type of plant in which there is apt to be the minimum amount of wear and the minimum amount of breakage because it can be designed with low bearing pressures, low unit fiber stresses, and such, and because it cannot in practice be subjected to greater loads than the designer could predict.

It is hardly necessary to point out that no one type of plant can be preeminently possessed of all the desirable quantities enumerated under (a) (b), (c), etc., above, but this only emphacizes the fact that each case is worthy of special study. The most economical solution can only be arrived at after balancing advantages against disadvantages, finally choosing that type of motive power which seems to possess those characteristics out of the long list already given which are of greatest import in the case in hand.

Review of Development to Date.

A review of steam power as applied to marine propulsion is hardly called for, as the majority of engineers are sufficiently familiar with it to realize its advantages and its shortcomings. On the other hand the internal combustion engine and its appurtenances are just becoming understood in their application to stationary work and there are probably few who know much of what has been done and is being done to adapt it to marine propulsion. For this reason a running outline of this part of the subject is now given.

The first recorded attempt to apply the internal combustion principle to marine propulsion was made by Lenoir shortly after 1860. He installed one of his engines in a small boat but met with so little success that the attempt passed into history as a failure. From twenty to thirty years of development of internal combustion engines for stationary purposes then ensued before any very serious and concerted efforts were made to solve the problem of water transportation by this means.

Development of the Gasoline Engine.

Gradually the small type of gasoline engine was developed to a point at which it operated with a fair degree of certainty so that it became available for use in small pleasure craft and even in small commercial boats such as ferries and the like. Its space and fuel economy were so great, the possibilities of cleanly and low temperature machinery so marked, and the ease of attendance so forcibly impressed upon those who had had to shovel coal into a boiler that it rapidly gained in favor among all classes.

During the past twenty years this type of machine has been perfected through the elimination of this and the addition of that until at the present day it is made absolutely reliable, economical in the use of fuel to an extent never before dreamed of in engines of this size, and withal low in first cost and repairs.

There is little doubt but that the popularity of the automobile and the evolution of a satisfactory motor for that vehicle had much to do with the later refinements of marine gasoline engines. It is a fact however that, while there is a type of small high speed engine built which is practically an automobile engine mounted aboard ship, there is also a distinctive type of marine gasoline engine. It might almost be said that there are two such types, commonly distinguished as light and heavy duty, but they have the same characteristics, differing only in degree.

Limits of the Gasoline Engine.

This characteristic marine type runs at much lower speeds than does the auto engine, such figures as 250 to 800 encompassing the range of rotative speeds excepting possibly in extreme sizes. It is characterized by clean cut and compact design, quiet and efficient operation, has enclosed crankcase, and is generally multi-cylindered except in the smallest sizes. In its general design it may be regarded as a cross between the high speed auto engine and the slower multi-cylinder vertical stationary engine. It has been built with as many as eight cylinders to the unit and in a few exceptional cases of such size as to develop 500 H. P.

In general the limit to size of these engines is set by the cost of the fuel. The fuel bill for an engine developing several hundred horsepower on gasoline assumes astounding proportions. For this reason practically all of the largest sizes are limited to installation on war vessels such as submarines and torpedo boats.

These gasoline engines are built to operate on the Otto cycle, both two stroke and four stroke. Four stroke operation predominates in the largest sizes but the two stroke process is holding its own, if not more than that, in the smaller sizes.

Nearly all engines of this type are irreversible, the propeller being made reversing for small sizes (up to 100 to 150 H. P.) and being connected to the engine through some sort of reversing mechanism in the larger sizes. Recently some of the larger engines have been fitted to reverse with the use of compressed air and have performed satisfactorily.

They can all be made to run at widely varying speeds by throttle and spark control.

Seeking Another Type of Engine.

The gradual rise of the selling price of gasoline in this country and the relatively high price of this fuel in Europe early led to attempts to modify these engines or to design engines of a different type, to the end that the cheaper fuels, such as kerosene, distillate and even fuel oil, might be utilized. This movement has as yet been more noticeable in England and on the continent of Europe than in this country, a fact probably due to the greater commercialization of the internal combustion boat on the other side of the water. A pleasure fleet such as ours is unknown there and looked upon with wonder, whereas the European fisherman and those engaged in the operation of canal boats, river barges, etc., set us an example which we might follow with considerable profit.

In England, the home of the stationary Hornsby Akroyd oil engine, this development took place along the lines proven successful by that well known and well tried motor. As a result there are now a number of successful marine kerosene engines in use in English and surrounding waters which owe their operation to the spraying of kerosene into a hot combustion chamber or bulb.

These engines have been brought to a high state of development, are built in sizes comparable with the gasoline

engines previously mentioned, and structurally along very similar lines. They all labor under the disadvantage that a lamp is required for starting and that a period of time variously estimated at from ten to thirty minutes is consumed in preliminary heating of the combustion chamber or bulb.

Marine Kerosene Engines.

Similar engines have been developed on the continent of Europe and to a certain extent in this country. The demand for such engines here has not been great enough as yet to produce many or much, while in Germany and surrounding countries a more promising solution has presented itself.

The great success of the Diesel oil engine in stationary work had its influence here just as the hot bulb stationary engine of England influenced development there. With the recent expiration of the Diesel patents firms in western and central Europe have become free to develop this type at will and some really marvellous work has been done along marine lines.

Both the hot bulb and the Diesel type have been built to operate on the two stroke and four stroke cycles but unlike the former the Diesel engine has been built double acting and in sizes up to 1,500 H. P. per unit with 2,000 H. P. in sight.

The Diesel Marine Engine.

The Diesel marine type is multicylindered like the others and in many examples very closely resembles them in general appearance, though there is a tendency in evidence to give them more and more the appearance of the reciprocating steam engine in many respects.

This engine has the great advantage that because of the cycle upon which it operates it is possible to obtain greater power per cubic foot of piston displacement with it than with any other internal combustion engine, and for the same reason this engine can handle much less volatile and hence much cheaper fuel than the other liquid fuel engines.

All these oil engines were first made non-reversible, backing being effected by means of reversing gears or reversing propellers. Within the last few years however, some few builders have succeeded in making hot bulb engines reversible and practically all the larger Diesel engines now constructed are reversible and direct connected to the propeller.

Before closing this brief review of liquid fuel internal combustion marine engines it should be mentioned that at least one American builder has constructed and installed double acting gasoline marine engines giving 300 H. P. per six cylinder unit. More than this these engines are perfectly reversible and are direct connected to the screw.

The development of internal combustion marine engines using gaseous fuels has not yet proceeded to the same extent as that of the engines already reviewed. The reason for this is that until the gas producer was made a commercial possibility there was no way of obtaining an adequate cheap supply of gas fuel on ship board. As a matter of fact the development of the gas producer for stationary work has hardly yet progressed to such a point that those concerned in its evolution and its successful future are satisfied that they have reached what may be called stable conditions. Many things connected with the practical operation of producers indicate the desirability of further research and further modification with the object of making it a more flexible, more reliable, and more efficient apparatus.

Marine Gas Producer.

The marine gas producer may be said to be non-existent at the present time. To be sure, quite a number of producers have been installed in vessels and have given satisfactory results, but most, if not all, of them are capable of handling coal of low volatile content only, are of small capacity, and involve the use of abnormally bulky cleaning apparatus.

Most of these producers have been merely stationary types installed aboard ship and are no more a solution of the marine gas problem than was the installation in connection with one of them of a horizontal double opposed gas engine by one of the prominent builders of Europe.

Some few producers have been designed and installed with the peculiar requirements of marine conditions in view but none of them have been more than acceptably successful and none of them seem to indicate the direction of the final solution.

In this state of the art the largest plant which one could install with a moderate degree of certainty of successful operation is probably one developing about 1,000 to 1,500 H. P. and this would probably call for two or even three producers. Each would have to have its clumsy and space-occupying cleaning apparatus. There would probably have to be at least two engine units, each having from four to six cylinders.

This would be little more than a stationary plant, modified to meet marine requirements to the limited extent which our present inadequate knowledge would permit. It could be made to operate on either anthracite or bituminous coal but would be bulky and costly.

Most of the marine producer gas engines already installed have been built for rotation in one direction only and were capable of operating only through a very limited range of speeds. Backing, and to a certain extent much of the maneuvering, has been effected through reversing gears, electrical connection or reversible propellers.

These engines have all been single acting and most, if not all, operated on the four stroke Otto cycle.

Inherent Advantages and Disadvantages of Internal Combustion for Marine Propulsion.

With this brief review of the development of the art and in the light of the requirements of marine operation we may now discuss the relative merits and demerits of internal combustion for marine propulsion. It will be noted as this discussion proceeds that some of the points in favor of this method of propulsion and some of those opposed to it are inherent in the nature of the working process and may not therefore be eliminated though they may be much modified, for good or for bad, by the excellence of the design in any particular case.

The points in question may be enumerated as follows:

(a) The internal combustion engine is much more sensitive to maladjustment than either the reciprocating steam engine or the steam turbine. This weakness is characteristic of the working process and while it may be minimized by careful design, by the duplication of certain small auxiliaries, by careful attention during operation, and such, it is bound to remain to a certain extent.

It ensues largely from two facts. First, in internal combustion engines of all kinds the process carried out for the production of power is largely chemical, in contrast to that of the steam engine which is almost entirely physical. The conditions under which the necessary chemical processes can be made to take place are much more limited than those which govern the occurrence of the physical phenomena connected wit\

steam engine operation. As an example of the contrast consider the working fluid entering the engine cylinder. With internal combustion operation is impossible unless combustible and combustor be mixed within certain narrow limits of proportion, whereas with steam operation can be continued with comparatively little difficulty if the normal pressure is not even approached or if the material arriving at the engine contains a very large proportion of water.

Second, there is the further fact that the working substance arriving at the power cylinder of the internal combustion engine is useless for the production of power until further prepared by the engine itself, in marked contrast to the case of the steam engine.

Require Competent Supervision.

It is the sensitiveness to mal-adjustment which has earned for these prime movers the reputation of being unreliable. Unreliable they are not in the broader sense of the word, but reliability is purchased only by competent and painstaking supervision and by a thorough appreciation of the intrinsic sensitiveness of their method of operation. This has been amply proven during the past few years on both land and sea.

The practical bearing of the matter is about this. Experience has shown that internal combustion engines in units of 1,000 to 1,500 H. P. can be so designed and operated as to be sufficiently reliable for satisfactory marine operation. So far as larger sizes are concerned one can only point to what has been done on land as an indication of what may be expected in the future on the water.

(b) The internal combustion engine has been most vehemently condemned for its inability to spring almost instantly into action at full load with the use of its normal cycle and normal working mixture. It may be pointed out however, that this is more or less a matter of view point

The Reciprocating Engine.

Take for example the other side of the case, namely that of the reciprocating steam engine, which is universally cited as a glowing example of what a well behaved marine engine should be. This engine is merely so much inert metal until from half an hour to several hours have been spent in getting up steam; this even when low fires are assumed in the boilers to start with. Then and then only can the engine be started. Or, assuming that a source of high pressure steam supply is available, where is the engineer who in his right mind would turn that steam into his pipes and engine without first spending from a few minutes to half an hour in "warming up" those parts?

Even then the engine is not started into action instantaneously nor with one setting of the valves. It is first turned over slowly and after a sufficient period of nursing into action with a deal of juggling of throttle and link it is finally brought up to normal operating conditions with valve mechanism in its final position.

The Pros and Cons.

Compare with this the case of the condemned internal combustion engine. If it is a gas engine and the producers are assumed to be in a condition corresponding to that of boiler furnaces with low fires a period of from twenty to thirty minutes is ample to bring them to the condition necessary for gas generation. If it is a liquid fuel engine no such period of preparation is required.

In either case, the working fluid being available, the turning on of high pressure air enables the internal combustion engine to start off as fast as its parts can be accelerated and within a few revolutions of the time of turning on air the engine can be operating in perfectly normal fashion with its normal working fluid. This start is well nigh instantaneous as compared with that of the steam engine just outlined.

Objections have been made to this method of starting on the score that it necessitates the existence of a store of high pressure air. True, but is not the storage of a small amount of high pressure air, compressed while the engine is in operation, by energy furnished by that engine, just as convenient and just as safe as the storage of high temperature heat in the boilers with all its attendant dangers and inconveniences, or the generation of that high temperature heat before the engine can be started?

Objection to this method of starting has also been made because it involves excessive shifting of valve gear. It is true that there is considerable shifting, but the manual operations connected therewith are practically the same as those involved in starting a reciprocating steam engine.

The fuel valve corresponding to the steam engine throttle and a lever controlling the functioning of air, inlet and exhaust valves corresponding to the lever controlling the steam engine link are certainly as easily handled as are their counterparts in steam practice.

If one includes the closing of the cylinder drain cocks, and the starting and adjusting of all parts connected with the condenser equipment one has more than a balance for the starting and adjusting of the cooling system of the internal combustion engine.

It looks almost as though an unbiased opinion might favor the latter form of engine so far as speed of strating and ability to pick up load are concerned and put both upon an equal footing so far as necessary manual operations at the engine are concerned.

Installation of Air Tanks.

A further criticism is sometimes voiced; namely that during starting the high pressure air is used up and if conditions should immediately call for sudden stopping followed by as rapid starting sufficient air would be lacking. It is, however, customary to furnish air tanks capable of holding a supply sufficient to start the engine from six to ten times in rapid succession and such tanks, even when storing air at only moderate pressures, do not occupy an excessive amount of space. From their very character they need not be get-at-able and may be stowed in the most inaccessible places; something which should be borne in mind in comparison with the location of the condenser in the steam plant.

(c) The internal combustion engine, no matter what its cycle, is at its best when operated under steady normal load and speed conditions, though the difficulties met in attempts to operate under fractional and variable loads are somewhat dependent upon the cycle chosen. The effect of the cycle will be further considered in a subsequent paragraph.

For the greater part of its useful existence the marine engine is called upon to operate at normal load and speed and these are ideal internal combustion engine conditions. Rough weather and maneuvering, however, entirely alter the aspect of things.

Rotating at Fractional Loads.

It has already been pointed out that one of the essential requirements of successful maneuvering ability is the power of the engine to constantly rotate at fractional loads and speeds and to change rapidly from one set of conditions to any other.

It must be admitted that this has offered great difficulties in the past and has led to the adoption or consideration of all sorts of intermediary devices between engine and propeller so arranged that the propeller conditions could be varied while practically constant conditions could be maintained at the engine.

More complete understanding of the problem has made possible the omission of such devices in the more recent installations. All of the newer and larger engines are capable of maintaining speeds anywhere between 25 to 50 per cent of normal and normal for indefinite time periods and some of them can be made to rotate at speeds as low at 10 per cent of their rated value. If all cylinders are to be kept in operation during these speed changes the operation of the average engine approaches the limit of reliability somewhere in the lower range of speeds and can only be made to operate successfully by a very careful adjustment of mixture, compression and time of ignition.

On the other hand if one is satisfied with a less perfect tangential effort at the lower rates of revolution it becomes permissible to cut some cylinders entirely out of operation allowing those remaining to carry more nearly normal loads and thus to function with greater reliability.

Flexibility of the Reciprocating Engine.

When all is said and done this engine must be admitted by its strongest partisans to be weak in this respect in comparison with the wonderfully flexible reciprocating steam engine in which the combination of throttle and link give such marvellous latitude. It is, however, a question whether this excessive flexibility is necessary to successful marine operation and whether we are not really condemning the internal combustion engine for not having steam engine characteristics, rather than for not having sufficient flexibility for satisfactory marine operation, when we put too much stress on this part of the subject. So far as experience has gone it seems to prove this to be the case.

(d) The internal combustion engine as at present constructed and installed has one weakness which under certain circumstances might prove decidedly inconvenient if not even dangerous. It is no uncommon thing for vessels operating in some parts of the world, and no impossible thing for any vessel, to run at full speed onto a sand bank or bar or other shoal and to stick there.

The steam driven boat can generally back off again under its own power because of the enormous overload capacity of its boilers and engines.

The internal combustion engine is not so favored in this respect. Producers to be sure are capable of short time overloads equal to or greater than those of boilers and are more easily handled under such conditions, but the engine itself is not in general capable of even a short time of overload of 20 per cent. This is insignificant in comparison with the ability of reciprocating steam engines.

Backing Power of Turbines.

It should not be forgotten in this connection that many of the recent marine turbine installations have been provided with a backing power of only 30 to 50 per cent of that of the ahead turbines.

The desired overload capacity can undoubtedly be obtained with internal combustion engines if it is deemed necessary. Two methods have been suggested. One, intensive working for a short time, hardly seems desirable as it involves a treatment of the factor of safety of the engine too uncomfortably like the treatment of time by the man who sets his watch five minutes ahead in order to be certain of catching a certain train and then later, when making the connection, allows for the fact that his timepiece is five minutes fast.

The other method is more feasible though it is only purchased at the expense of additional weight and bulk. It is the very simple expedient of copying the steam engine cycle and obtaining a rectangular diagram. Of course this must be done with high pressure gas and involves the storage of high pressure air or liquified gas with the attendant inconveniences. It is, however, a possibility if deemed necessary.

Comparative Dangers of Fuels.

(e) The fuel used by liquid fuel engines must be regarded as dangerous when of the more volatile varieties but the heavier oils can be transported safely and with great convenience. Fortunately our most efficient and largest marine engines are well adapted to handle this variety.

Producer gas is also a dangerous fuel because of its poisonous nature as well as its explodibility. It is, however, a question whether the dangers associated with the use of gasoline or producer gas are any greater than those accompanying the use of high pressure steam. We have become familiar with the latter and therefor regard it with more or less of the proverbial contempt, but the records show that our contempt is far from warranted.

With correct attention to detail in design much can be done to minimize the dangers accompanying the use of high pressure steam and by the same means the use of producer gas can be safeguarded. No refinement of design, however, will prevent a careless attendant from turning a mixture of air and gas into the piping system any more than it will prevent a similar individual from suddenly connecting an intricate pipe system at room temperature with a high pressure steam boiler.

At least, however, the danger is generally over after rupture has occurred in a producer gas system whereas in a steam system it is just about to begin. The word "generally" is used advisedly in the preceding sentence. It must not be forgotten that a producer filled with hot fuel creates sufficient draft to continue the production of combustible gas long after all artificial draft has ceased. This property might in case of a bad accident assume considerable importance.

Economy of Fuel.

(f) The greatest advantage to be gained from the use of internal combustion is economical utilization of fuel. The conversion into useful work of from 20 to 30 per cent, or more, of the heat in the fuel is something well worth while. In comparison with steam it either decreases the weight and bulk of fuel to be carried or it increases the radius of action with a given weight of fuel aboard.

It should be noted, however, that if this decreased weight of fuel is accompanied with increased weight of power plant it may happen that nothing is gained, or even worse.

As a matter of fact it is really too early to say just what the weight of internal combustion plant may average per horsepower in different types. This may be said, however, without fear of contradiction. The liquid fuel engine makes possible a very material saving in both weight and bulk of plant over any other means of propulsion yet devised, and certain forms of these engines give the high-

est fuel efficiencies yet recorded for marine engines. This is proved by actual working installations.

Saving of Weight.

The gas engine installations so far installed have shown the possibility of a saving of weight as against reciprocating steam engines when considering entire plant against entire plant in operating condition. Space economy is as yet rather uncertain and it seems probable that unless larger producer units can be made any large gas engine installation which the future may bring forth will be seriously handicapped in this respect. By larger producer units is meant units capable of producing greater horsepower per cubic foot of space occupied as well as per single producer.

Experiments are now in progress which indicate the possibility of at least doubling and probably more than doubling the space economy of producers. If this can be done the large marine gas installation offers both weight and space economy.

Decrease in Number of Crew.

(g) Another, and in many cases a very considerable advantage to be gained from internal combustion is a decrease of the number of operatives required in comparison with steam propulsion. This is accompanied by a bettering of the conditions under which some of them must work. In all probability no such arduous labor as is necessary in a modern stokehold will ever be associated with a marine producer installation.

This decrease of numbers is to be expected only at the point where the working substance is prepared for reception by the engines and not at the latter. The liquid fuel engines require no hands to prepare their working substance and gas engines require comparatively few as compared with a steam engine.

(h) The ability of the producer to handle fuel absolutely unfit for boiler use may be an additional advantage in favor of the former but this is rather doubtful, as poorer fuel means greater weight and bulk per horsepower hour and consequently smaller carrying capacity on the part of the vessel.

So far as marine producer construction has actually progressed the available fuels are woefully limited in variety but with the progress made in stationary practice during the past few years it seems probable that this state of things is only due to the very youthful condition of the art. Present activities point to the early development of the marine producer to such a degree of perfection that it will handle any fuel which it will pay to transport.

Multi-Cylindered.

(i) The natural internal combustion engine unit is a multi-cylindered construction in which all cylinders are exactly alike as to size, weight of moving parts, pressures, etc. This characteristic goes far toward the solution of the balancing problem and favors even tangential efforts.

More than this a six cylinder unit with all its inherent advantages in these respects is as natural a structure for the internal combustion engine as are the two, three, or four cylinder constructions for steam engines with the poorer arrangements of characteristic forces which they involve.

It is of course true that the internal combustion engine, even in a six cylinder unit, does not offer the wonderful balancing and turning possibilities possessed by a steam turbine. Balance and even turning effort on the part of a reciprocating engine must at best be forced in character. While the machine as a whole may exhibit commendable characteristics they are only achieved at the expense of all sorts of internal strains.

In comparison with the steam turbine, however, the six cylinder unit does not give a mean performance by any means, and the other advantages that it possesses are sufficient to outweigh its shortcomings in this respect.

High Rotative Speeds.

(j) In comparison with what has been considered good steam engine practice high piston speeds combined with high rotative speeds are characteristic of the internal combustion engine. This is not, as is commonly supposed, due to the structural difficulties encountered with increasing diameters so much as it is to the fact that these speeds give the best average cylinder conditions for the efficient generation of power by this process. These speeds are therefore truly a characteristic of the process.

Curiously enough, they are about the speeds which naval architects have claimed would give most efficient propeller operation. If such proves to be the case throughout the range of sizes in which such engines may be built it is another point in favor of internal combustion.

(k) The powers to which internal combustion engines can be built seems to be limited. In some cases this limit is apparently set by the cylinder process itself as in the case of oil engines with which about 200 to 300 H. P. per four cycle, working cylinder end has generally been taken as the maximum attainable. In other cases the strength of the parts seems to set the limit as in the case of the gas engine in which 600 to 700 H. P. per four cycle, working cylinder end seems to be the best that can be done.

Such is the limit today but he who will say that it will be the limit tomorrow has less faith in human ability than is warranted by past developments. The figures given above certainly represent achievements worth while in an industry only a little more than a decade old and promise more to come.

It is not yet commonly known that only a short time ago one builder of marine Diesel oil engines made a small alteration in the working process which greatly increased efficiency, greatly increased flexibility, and appreciably increased power per cylinder end without putting additional strains upon the structure. This, it should be remembered, was done with an engine which was believed to have reached its limit of development, and further, it was done with an alteration so slight that it would not even be noticed on a casual inspection of the engine.

Who will say what may happen tomorrow or the next day?

(l) The equipment of vessels with gas power has been called impracticable, not because of any difficulty in propelling the vessel but because such an equipment did not offer satisfactory solutions to the problems of heating the vessel, cooking, operating, steering and similar auxiliaries, etc.

Is this not something like swallowing a camel and straining at a gnat?

The Question of Cycle.

As a matter of fact at least one vessel using liquid fuel in internal combustion engines has been successfully heated without the use of steam boilers, mess is served regularly on such vessels, and auxiliary machinery is economically operated. Such small and incidental problems should not be regarded as offering any very serious obstacles to the progress of gas power.

Before attempting to predict what course marine internal combustion power may be expected to take in

the future it will be advisable to consider the question of operating cycles at some length. Four radically different cycles have been used already and they have each shown certain limitations.

These cycles are the so-called Diesel and Otto cycles and each one has been carried out in two-stroke and four stroke operation.

In theory the two stroke cycle should give twice the power obtained from four stroke operation in the same size of engine operating at the same speed. Practically, however, the ideal can never be attained and thus the theoretical saving of weight does not appear in the actual construction.

In the first place the nature of two stroke operation is such that pumps are required to charge the working cylinder. As the power consumed in friction and in useful work by these pumps must be subtracted from that developed by the working cylinders and as the useful work of the pump is entirely used up in the charging operation the net power developed by the engine is less than would be expected from theoretical considerations only.

In the second place, the cylinder action never is as perfect as with four stroke operation, largely because of the short time available for exhaust and admission. This is generally further aggravated by the fact that they overlap to a certain extent. Exhaust is imperfect, as the charging operation is also relied upon to complete it and, as there is always more or less mixing of new and old charge, a relatively large amount of burnt gases must be retained in the cylinder or a measurable quantity of the incoming material must pass out through the exhaust ports.

This phenomenon means that a diluted charge must be carried through the working cycle with a corresponding loss of capacity or that some of the material compressed by the pumps must be wasted through the exhaust ports without the doing of useful work in the cycle and with a corresponding loss of pump work. Where scavenging is effected with the use of a combustible mixture there must also be a corresponding loss of fuel.

The Two-Stroke Principle.

Liquid fuel engines operating on the two stroke principle have given greater economy than have gas engines and for very obvious reasons. Two pumps are required with gas engines, one for the combustible and the other for the combustor, while one pump suffices for the operation of the liquid fuel engine. Further, scavenging can be done entirely with air in the oil engine, the oil being injected in such a way and at such a time that there is no danger of fuel loss.

It is then but natural that the two-stroke oil engine should find wide application in marine work.

These engines have been built to operate on both the Diesel and the Otto cycles and of the two the former has proved itself preferable. The nature of the cycle is such that it permits of the attainment of higher efficiencies than does the Otto because the compression pressure and the maximum pressure attained are almost equal, in marked contrast to the three or four fold increase with constant volume combustion. Further, the shape of the Diesel cycle, that is the relation of pressure and volume, is such that the maximum pressure is longer sustained, approaching steam engine conditions with their advantages.

Experience has also shown that the Diesel cycle engine permits of a wider range of loads and speeds than does the Otto cycle engine with less danger of approaching unstable operating conditions. The advantage of this property is evident in the light of the preceding discussion.

From a practical standpoint, the Diesel engine lends itself more readily to double acting construction than does the Otto oil engine, the latter probably never having been built in this form.

All things considered, the two stroke cycle, double acting, Diesel oil engine with its small number of necessary valves, its comparatively light weight, its ability to handle the cheaper forms of liquid fuel, its inherent high efficiency, and its great maneuvering ability, is an ideal marine engine.

On the other hand the gas engine is considerably handicapped in many respects. It flourishes best in four stroke Otto form and thus requires a plentitude of valves. These lead to difficulties in constructing double acting vertical types and to complications in arranging for reversal of direction of rotation. This cycle is not naturally adapted to the development of an even turning effort, nor is it as well adapted to maneuvering as that just discussed. Further, igniters are required for the practical development of the Otto cycle and, as is well known, they form one of the weakest links in the power chain.

What is to be Expected?

We may now ask ourselves "What next " "What are the coming years to bring forth?" Certainly many vessels propelled by internal combustion engines. The accomplished facts, the natural advantages, the decreased operating expenses, all assure us of that, but the questions of type, size of unit, size of vessel that can be equipped, and so forth are not answered thereby.

The 2,000 H. P. Diesel unit is assured and experiments now in progress point toward the early development of a 3,000 H. P. engine if necessary and open possibilities toward 4,000 H. P. Assuming, however, that the economic limit is reached at 3,000 H. P., that is sufficient to drive an 11,000-ton vessel at a speed in the neighborhood of 10 to 14 knots, depending on type of hull. Three such units on three screws would obviously represent no mean installation and would enable us to drive our vessel at 16 to 18 knots or more.

Such figures are particularly enticing to these operating medium sized freighters or combined freighters and passenger boats. The use of half the amount of fuel needed with steam power, or even less than that, the elimination of the boiler plant with its rapid depreciation and high cost of repairs and its large operating force, the gaining of all space occupied by this part of the plant together with half that originally used for the storage of fuel open up possibilities that no wide awake navigator can afford to overlook.

If one is inclined to be optimistic and grant the early development of 4,000 H. P. units the field opened up becomes still broader but it is hardly necessary to go so far to recognize the enormous and immediate possibilities of this form of power developer.

Future of Producer Gas.

Turning to what may be expected of the gas engine, we are confronted with the producer problem more than with the engine problem. With the incentive as strong as it is, and with no natural laws standing in the way it seems reasonable to assume that the producer will be developed for marine purposes to at least the same extent as it has already been applied for stationary work. There are producers now in operation which gasify from ten to more times the commonly

accepted weight of fuel per square foot, per hour, and while they are hardly adapted to marine conditions they still serve to point out what may be expected. This indicates that the producer will probably follow the engine wherever it may lead.

Looking at the engine then, we find that up to the present time it has been built single acting only for marine purposes, and that units of about 500 H. P. are about the largest that have been installed. There is, however, no great difficulty in sight in producing single acting engines capable of delivering from 400 to 500 H. P. per cylinder and if we use the natural unit of six cylinders this would give us about 2,500 to 3,000 H. P. per engine. This it will be observed is similar in size to the oil engine just considered. It would, however, be excessively heavy for the power devoloped if producer weights be added in.

Making this unit double acting would practically double the power with much less than a corresponding increase of weight. Whether or not this can be done is still questionable; very appreciable difficulties are encountered in attempting to design a vertical, double-acting, four cycle, gas engine because of the valves which must be provided for the lower end of the cylinder. Designs are now extant which seem to prove that it can be done.

Because of the success of the oil engine, it will probably be a number of years before gas engines of such design will be attempted.

If it should prove possible to carry the development of the marine gas engine to the point at present attained in stationary practice, and if the producer can keep up with this development a triple screw vessel might be expected with a power plant of from 15,000 to 18,000 H. P. This brings us within range of a number of other types of vessel and opens up a still broader field for the application of the internal combustion engine.

When it is realized that the operation of such a plant would mean the saving of from ½ to 1 lb. of coal per horsepower hour, that is from 3¾ to 7½ tons per hour or from 630 to 1,260 tons per week the great incentive toward the development of this form of power is obvious.

With all this nothing has been said about that youngest child of internal combustion, the Humphrey gas pump. What this may make possible no one yet knows, but tentative designs of rather revolutionary, though sane, character indicate methods, possibilities, and savings before undreamt of.

Is this not truly one of the most vital and interesting problems of the present day?

Twelve Months' Experience with Geared Turbines in the Cargo Steamer Vespasian*

By the Hon. C. A. Parsons and R. J. Walker.

THE object of the present paper is to lay before the members of the institution a brief account of a year's working of the Vespasian; it may also be considered as a continuation of the paper read at the spring meetings of last year on "The Marine Steam Turbine and Mechanical Gearing."

On completion of the trials referred to in last year's paper, the Vespasian was taken to sea on several occasions in light condition with a view to observing the behavior of the propelling machinery in a seaway. Although no very severe weather was encountered during these trials, sufficient evidence was obtained to show that the engines were not liable to race in heavy weather.

A series of careful observations was made of the variation in revolutions of the engines with the vessel pitching. The governors on the turbines were so adjusted as to come into operation when the revolutions of the engines exceeded 1,600, corresponding to 80 revolutions of the propeller shaft. Records were first taken at a normal rate of revolutions of 72 on the main shaft. The vessel was put head to sea, and during a period of pitching the revolutions of the propeller shaft reached a maximum of 82 at the moment when the stern of the vessel had reached the maximum angle of longitudinal inclination, the immersion of the propeller under this condition being about 6 in. to 12 in. The governors of the turbines came into action just as the maximum angle of inclination was reached.

Further observations were made with the governors readjusted to higher revolutions, and the average records obtained showed a maximum variation in revolutions of from 72 to 84 during a period of pitching. The steam pressure at the high pressure turbine remained constant throughout at 70 lb. pressure.

*Read at the spring meetings of the fifty-second session of the Institution of Naval Architects, 1911.

As the result of these trials it was found that even with the governors out of action the acceleration of the engines during a period of pitching did not exceed 16 per cent as a maximum, due to the very great angular momentum of the turbine.

In order to test the durability of the gearing, the Vespasian was placed in regular service on June 9 last year, carrying coal from the Tyne to the continent, and returning in water ballast. From that date to the present time she has completed 26 trips to Rotterdam and six trips to Antwerp, and during this period has steamed about 20,000 miles.

At various intervals the gear wheel and pinions have been inspected and tested for "back-lash," and only a month ago this was done, when practically no slackness in the teeth of the gearing could be detected. The wear in the teeth so far seems to be a negligible quantity.

We have here today for the inspection of the members of the institution one of the actual pinions of the Vespasian, which has been in constant use since the new machinery was installed, the vessel having steamed over 18,000 miles prior to its removal.

On the first four voyages careful measurements of water consumption were taken. The following table gives the data and results obtained on these voyages.

The service results agree very closely with the trial results. The displacement of the vessel on service when the data were taken was 4,560 tons, being about 5 per cent greater than on the original trials.

In regard to the general behavior of the machinery, it may be mentioned that during the winter months the vessel has encountered some exceptionally severe weather, especially in light condition, and the turbines and gearing have worked throughout with entire satisfaction, and have not given the least trouble whatever.

Date—	9/vi/10	16/vi/10	16/vi/10	21/vi/10	21/vi/10	21/vi/10	29/vi/10
Speed by log, knots	9.35	9.22	10.58	9.61	9.27	10.22	9.37
Revolutions per minute	65.0	64.9	73.0	64.8	63.85	70.6	62.9
Boiler pressure, lb. per sq. in.	137	135	145	135	135	140	135
High-pressure turbine (initial pressure, lb. per sq. in.)	86	86	121	86	86	111	81
Vacuum (in inches)	28.5	29.1	28.6	28.55	28.4	28.4	28.3
Barometer	30.01	30.5	30.52	29.9	29.9	29.88	29.6
Water, main engines, lb. per hour	12.140	12.300	15,680	11,890	11,730	14,510	11,100
Shaft horsepower	740	736	1,080	735	710	960	668

A very noticeable feature has been the remarkable freedom from racing of the engines under conditions when the propeller has been entirely out of the water, confirming the observations made on the earlier trials when the engines, under the worst conditions, did not tend to accelerate in revolutions more than 16 per cent. The engineer of the vessel reports that without the aid of a sensitive tachometer it is very difficult to observe any acceleration in the speed of the engines.

On one occasion, namely, Oct. 12, when the vessel was returning in water ballast from Rotterdam, a very severe northeast gale was met with, necessitating increasing the steam pressure at the engines by about 25 per cent, to make headway against the heavy sea running.

With a view to experimenting with different qualities of steel, additional pinions were made, one of chrome nickel steel with a tensile strength of 55 tons, elastic limit of 38 tons, and an elongation of 20 per cent in a length of 2 in., and two of special carbon steel of 40 to 45 tons tensile strength, elastic limit 22½ tons, and an elongation of 20 to 25 per cent. The original pinions were of mild chrome nickel steel with a tensile strength of 37 to 38 tons, and an elastic limit of 32 tons.

The chrome nickel steel pinion of 55 tons tensile strength was tried in August last, but was removed after two voyages, as on examination it was found to be fractured at the corners of some of the teeth. This appeared to be due to the teeth having been irregularly machined and bearing over one-third of their length only; the material also appeared to be of too brittle a nature. The original pinion was replaced and is still in use.

The pinion removed last month for the inspection of the members of the institution has been replaced by one of the special carbon steel set of 40 to 45 tons tensile strength, and is in use at the present time.

At the end of last year a new propeller was fitted to the vessel; this one was of the same diameter and designed blade area as the original propeller, but with a finer pitch ratio. The actual dimensions of the new propeller are as follows: Diameter, 14 ft.; pitch, 14.14 ft., and expanded blade area, 72 sq. ft., as compared with the original propeller of 14 ft. diameter, 16.35 ft. pitch, and 70 sq. ft. expanded area.

The following table gives the data and results of a trial carried out off the Tyne on Jan. 9 of this year, the vessel being loaded to the same displacement as on the original trial:

Speed in knots	9.31	9.66	9.94	10.34
Revolutions per minute	68.4	71.2	73.7	77.0
High pressure turbine, initial pressure	76	86	96	109
Boiler pressure, lb.	130	142	146	141
Vacuum (in inches)	28.8	28.6	28.55	28.4
Barometer	30.2	30.2	30.2	30.2
Shaft horsepower	630	720	815	945
Water consumption, main engines, lb. per hour	10,400	11,510	12,590	14,000
Water consumption, lb. per shaft horsepower hour	16.5	15.98	15.45	14.81

The speed of 9.3 knots, which is about the average service speed of the vessel, the water consumption per hour has been further reduced with the new propeller by about 7 per cent, 4 per cent being attributable to the increased efficiency of the turbines running at the higher revolutions, and the remaining 3 per cent due to a slightly more efficient propeller.

In regard to the question of economy generally, as mentioned in the reply to the discussion on last year's paper, we do not profess that the results obtained with the Vespasian are the highest obtainable with geared turbines. In a new vessel, and with new boilers, say, of about 180 lb. pressure, a consumption of about 12½ to 13 lb. per shaft horsepower of the main engines, as compared with 16 lb. at the service speed of the Vespasian, could confidently be expected in an installation of, say, 1,000 H. P., which would be equivalent to 11½ to 12 lb. per indicated horsepower of reciprocating engines, assuming a ratio of shaft horsepower to indicated horsepower of 91 to 92 per cent.

In conclusion, it may be mentioned that the introduction of gearing into war vessels presents great advantages, since its adoption would result in increased economy, more especially at cruising speeds.

Cunard Liner Ascania

Swan, Hunter & Wigham Richardson recently launched from their yard at Wallsend-on-Tyne a liner for the Canadian service of the Cunard Co., making direct sailings from Southampton to Montreal and Quebec. The steamer was christened Ascania and is of 10,000 gross tons. Her engines are triple-expansion and she is fitted with all of the modern safety appliances, such as submarine signals and wireless telegraph. She carries only second and third class passengers and the fares are consequently quite moderate. She made her maiden trip in May.

Mississippi-San Francisco Service

The steamer George Fenwick, of the California Atlantic Steamship Co., known as the Bates & Chesebrough line, left San Francisco on May 27, inaugurating the Mississippi Valley-San Francisco service, announcement of which was made some months ago. Officials of the company state that the time from San Francisco to New Orleans will be 25 to 30 days and to St. Louis 40 days. Sailings will be semi-monthly.

The rate schedule published on May 16, shows that in some cases rates are reduced as much as 50 per cent below the railroad figures. The following table shows the rates on the principal commodities, also applicable to New York and Philadelphia:

	Rates in cents per 100 lbs.
Beeswax	.65
Beans and peas (in double sacks or single sacks of 12 oz. burlap or heavier)	.45
Beans and peas (in single sacks lighter than 12 oz. burlap.)	.50
Fruit, dried (in boxes.)	.45
Fruit, dried (in bags.)	.50
Fruit and vegetables (canned)	.45
Herbs (in compressed bales.)	.75
Honey, strained in tin cans, boxed strapped	.60
Kernels, nut, in cases	.60
Edible nuts	.50
Salmon, canned	.45
Barley	.35
Asphaltum	.35
Rough lumber	.40
Tallow	.40
Wool	.45

The rate on wine has not yet been announced.

The North Pacific Coast Steamship Co.'s steamer Kilburn, which was badly damaged by fire at the Oakland, (Cal.) land wharf last summer, has been rebuilt at the yards of the Pacific Shipyard & Ways Co., at Oakland, and will be placed on the coast run as a passenger and freight carrier. The vessel has been lengthened 35 ft. and practically rebuilt. Its present dimensions are 212 ft. length and 28 ft. beam.

Isherwood System of Construction

BY ROBERT CURR.

Sectional suction dredge, 130 ft. over all, 36 ft. wide and 12 ft. deep at sides.

The following plans show a comparison between the transverse framing

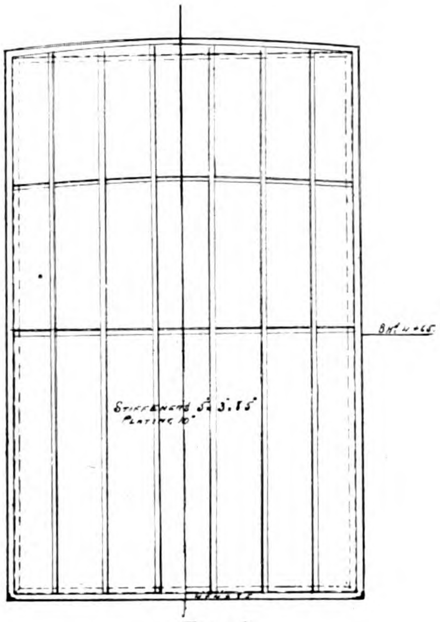


FIG. 3.

in general use and the new type of construction, the Isherwood system.

This sectional dredge is composed of six parts, the two center parts carrying all the weight.

The sides are simply pontoons which are necessary for raising the center parts and keeping the dredge upright while in operation.

The transverse framing arrangement as shown by plans No. 1 to 4, has a weight of 220 tons of steel.

The longitudinal arrangement, as shown by plans No. 6 to 9, weighs 172 tons, thus favoring the Isherwood system by 50 tons. This means less time in doing the work and effects considerable saving in cost.

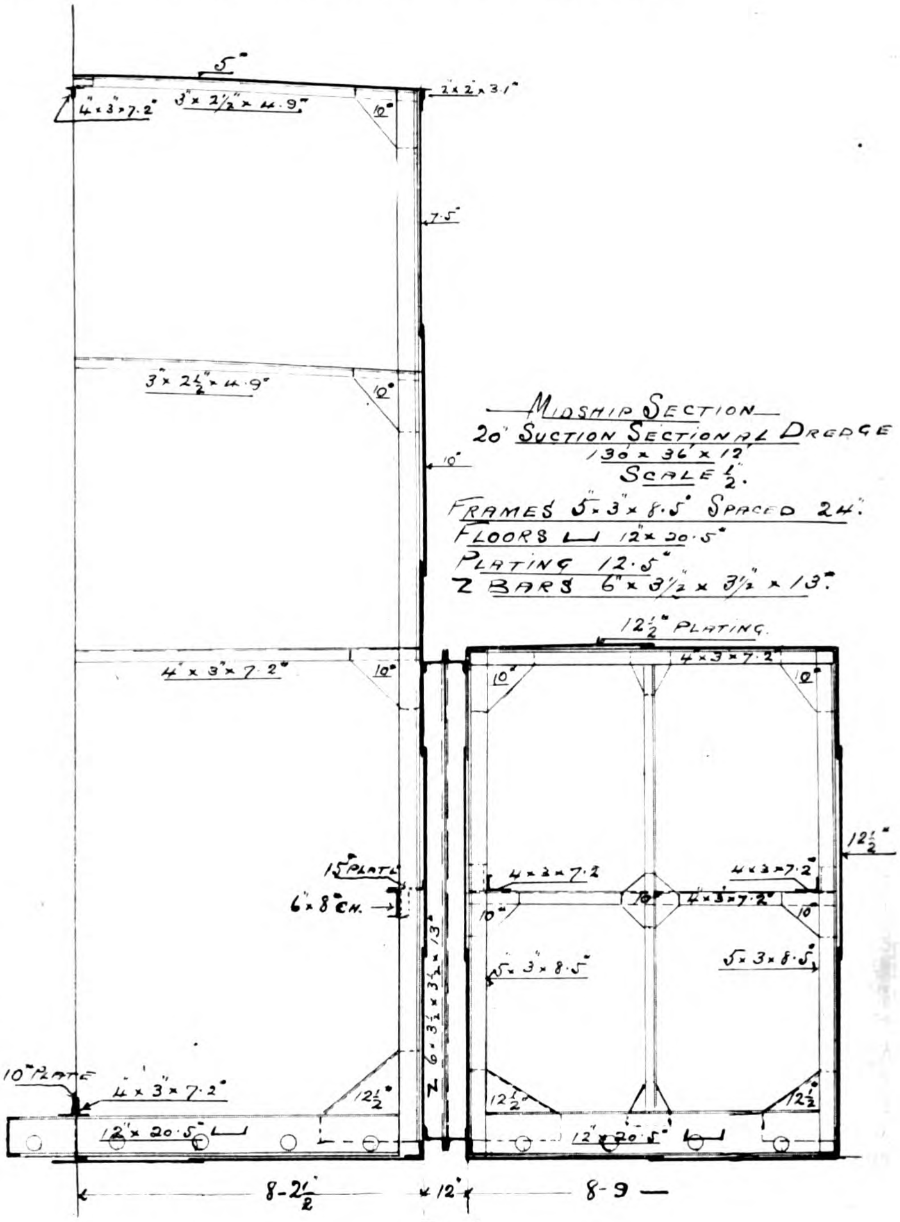


FIG. 1.

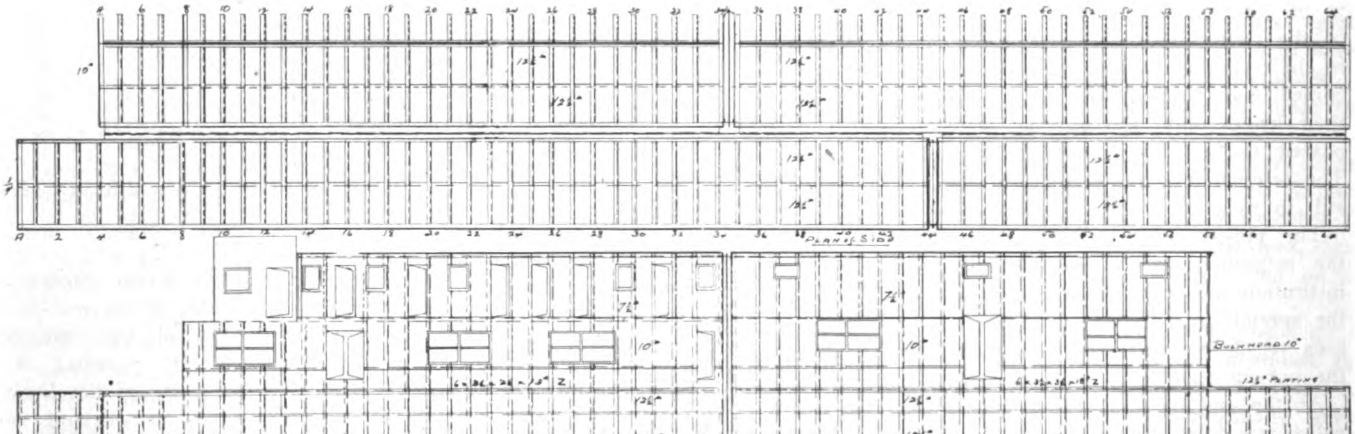


FIG. 2—PLAN OF CENTER.

Plan No. 1 shows the cross section amidships with all the sizes of materials in the vessel.

FRAMES—Angle 5 in. x 3 in. x 8.5 lb., spaced 24 in. apart.

FLOORS—Channel 12 in. x 20.5 lb., spaced 24 in. apart.

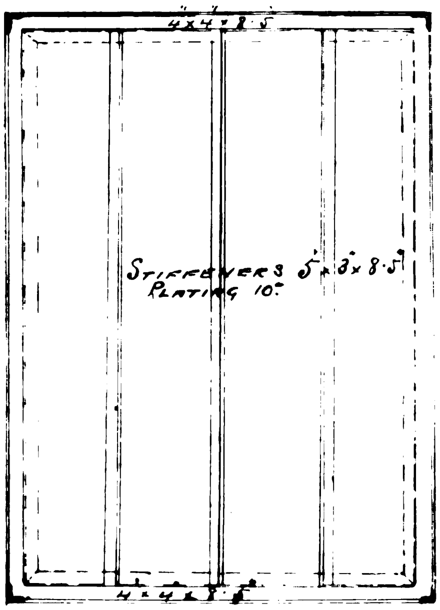


FIG. 4.

FLOORS—Bracket 30 in. x 30 in. x 12.5 lb. per sq. ft.

BEAMS—Engine room, angle 4 in. x 3 in. x 7.2 lb.

BEAMS—Cabin floor, angle 3 in. x 2.5 in. x 4.9 lb.

BEAMS—House top, angle 3 in. x 2.5 in. x 4.9 lb.

BEAMS—Ridge bars, angle 4 in. x 3 in. x 7.2 lb.

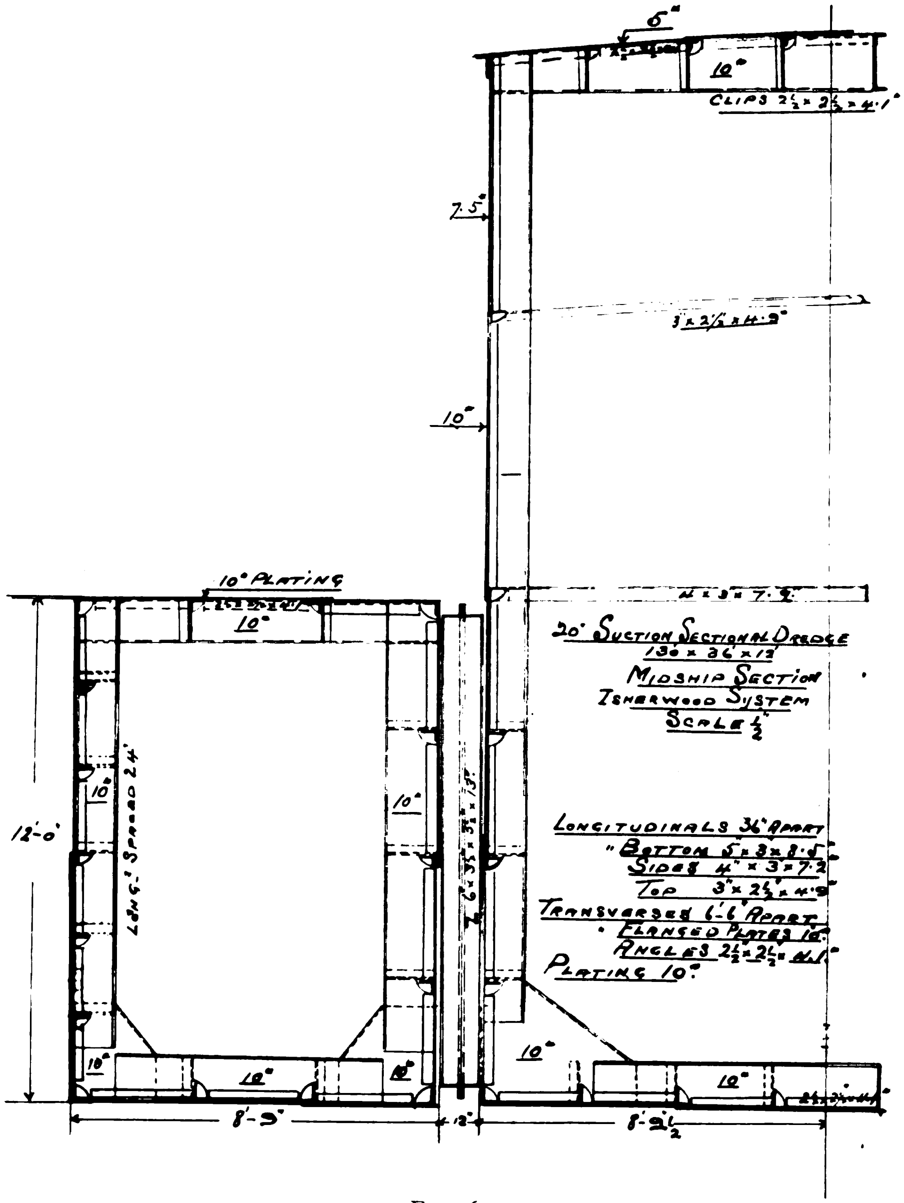


FIG. 6.

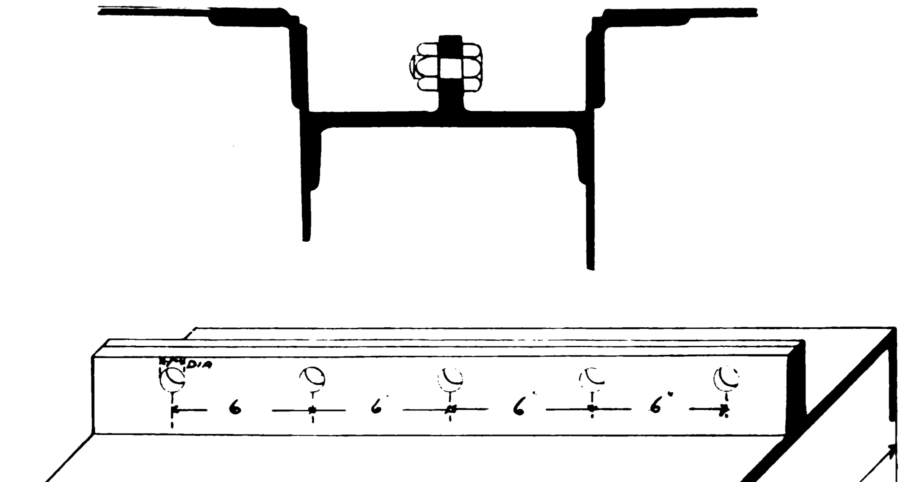


FIG. 5—DETAIL OF FASTENING PARTS TOGETHER.

Stanchions to suit location and number.

Center keelson double angles 4 in. x 3 in. x 7.2 lb.

Center keelson intercostal plate 10 lb.

Side stringers, channel 6 in. x 8 lb.

Side stringers, intercostals 15 lb.

Braces and stanchions in sides, 4 in. x 3 in. x 7.2 lb.

The bracket plates connecting floors and frames, 12.5 lb.

All other brackets, 10 lb. per sq. ft.

All plating under the two top strakes, 12.5 lb.

Second strake of plating below top, 10 lb.

Top strake of plating forming cabins, 7.5 lb. per sq. ft.

Plan No. 2 shows elevation of the outside of center and side parts and plans of half of center part and sides. This plan shows the distribution of the materials shown on plan No. 1.

Plan No. 3 shows the bulkheads in

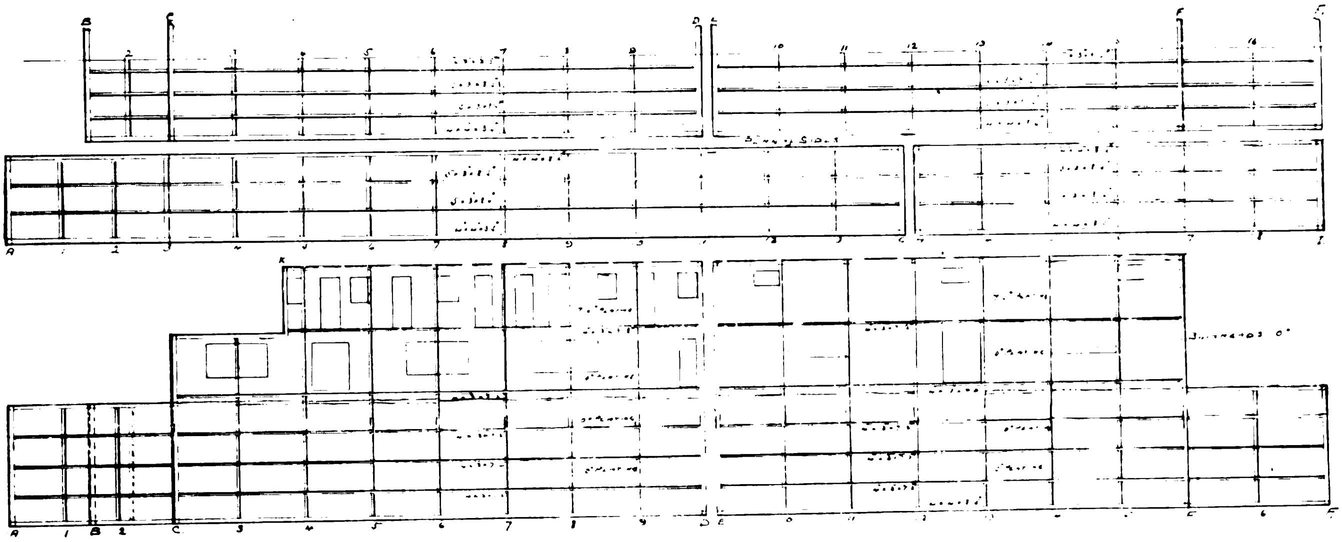


FIG. 7—PLAN OF CENTER PART.

the center part of the vessel which run to the house top.

The bulkhead plating is 10 lb. per sq. ft. and the stiffeners 5 in. x 3 in. x 8.5 lb. spaced 27 in. apart.

The dotted lines show the "Z" bars for fastening the parts together.

The outside angles are 4 in. x 4 in. x 8.5 lb.

Plan No. 4 shows the bulkheads at

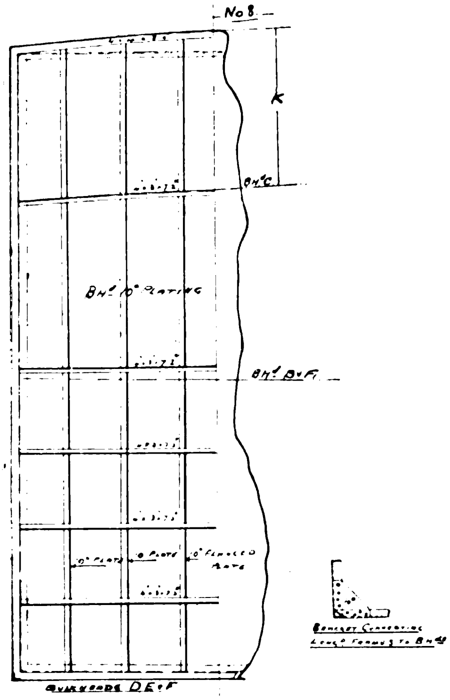


FIG. 8.

ends of side parts which are composed of 10 lb. plate and 5 in. x 3 in. x 8.5 lb. stiffeners spaced 27 in.

The corner angles are 4 in. x 4 in. x 8.5 lb. The dotted lines show the "Z" bars for fastening the parts together.

Plan No. 5 is detail of fastening the different parts together. One in. diameter bolts are used spaced 6 in. apart center to center.

Isherwood Section of Construction.
Plan No. 6.

Plan No. 6 shows the midship section of the Isherwood system. Transverses are formed of 10-lb. plate flanged on the face with intercostal angles connecting same to outside plating. The angles are all 2.5 in. x 2.5 in. x 4.1 lb. on these transverses. The beams are the same as in the other case, but it is not necessary to put in stanchions to the top of the house nor is it necessary to use ridge bars under the house beams. The outside plating is reduced to 10 lb. The framing runs lengthways and spaced in the bottom 27 in. apart. These bottom frames are 5 in. x 3 in. x 8.5 lb.

Side frames are 4 in. x 3 in. x 7.2 lb., spaced 36 in. apart.

Outside pontoon frames are 4 in. x 3 in. x 7.2 lb., spaced 24 in. apart.

Top frames are 3 in. x 2.5 in. x 4.9 lb., spaced 27 in. apart.

The two top strakes of plating for the house and plating on top of house are the same as in the transverse frame construction.

Plan No. 7 shows the arrangement of the frames placed longitudinally.

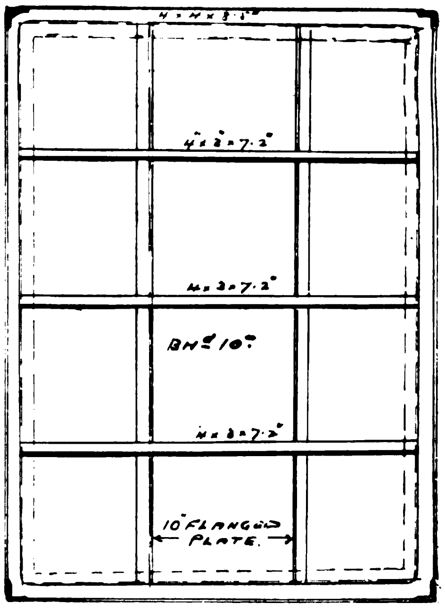
The plating on the outside and bottom laps on the frames.

The frames are in one piece from bulkhead to bulkhead and connected to 10-lb. flanged plates on the bulkheads, forming a truss.

Plan No. 8 shows the bulkheads, which run to the top of the house. The bulkheads are composed of 10-lb. plating and stiffened with cross angles 4 in. x 3 in. x 7.2 lb. and verticals similar to the transverses.

The vertical plates have the longitudinals riveted to same, top and bottom, and the cross angles are connected to the side longitudinals with 10-lb. plate brackets, as shown on plan.

Plan No. 9 shows the ends of the side sections. These bulkheads are composed of 10-lb. plate, 12 in. x 10-lb. flanged verticals connected with top and bottom longitudinals and cross angles 4 in. x 3 in. x 7.2 lb. connected to longitudinals with plate brackets, as shown on plan No. 8.

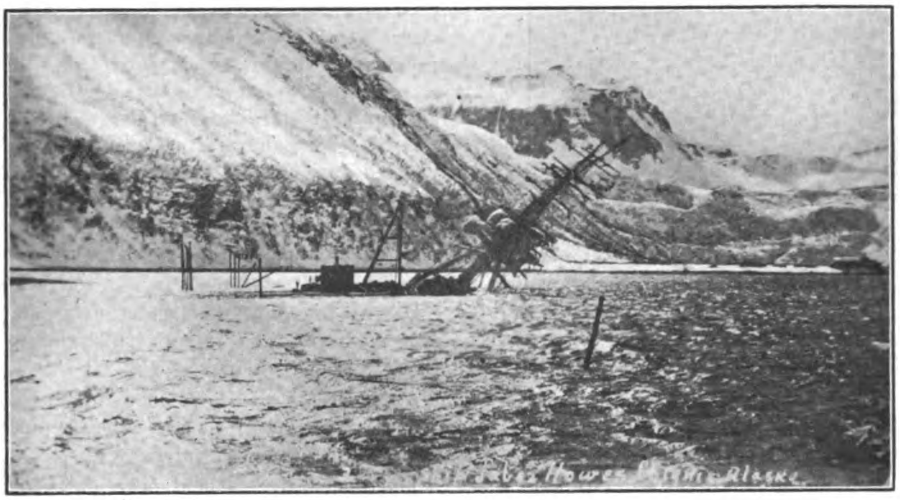


NO. 9—SIDE PART BULKHEADS, ISHERWOOD SYSTEM.

The Maryland Steel Co., Sparrow's Point, Md., laid the keels last week, of two self-propelling oil barges, 165 ft. long, 25 ft. beam and 11 ft. deep for the United States navy. Each will have a cargo capacity of 153,400 gallons and will be used to serve the fleet with fuel oil in Hampton Roads.

Wreck of the Jabez Howes

SEATTLE, May 24.—The old wooden ship Jabez Howes, owned by the Columbia River Packers' Association, is the latest cannery vessel to fall victim to the elements in Alaskan waters. In fact, the Alaska cannery fleet for years has been particularly unfortunate and underwriters have suffered some very heavy losses. In 1910, however, owners and underwriters were fortunate, as not a single cannery tender was lost or even seriously damaged. The present season has had an inauspicious start. Carrying supplies and employes for the company's cannery at Chignik, Alaska, the Jabez Howes left Astoria, March 14, arriving at her destination April 6 in company with the ship Benjamin F. Packard from Seattle and Star of Alaska from San Francisco. No sooner had these vessels arrived than a terrific southerly gale sprung up, causing the vessels to drag their anchors. It was impossible to stop them and all were soon ashore. By strenuous effort and with the aid of the rising tide, the ships were soon after floated. However, the Jabez Howes had been so severely strained that she leaked at an alarming rate. When it was found impossible to stop the inflow of water, it was decided to run the vessel ashore and beach her in shallow water. Consequently sail was spread and the vessel took the ground under canvas with such force as to spring her masts and bend them forward. The old ship settled in the sand with a dangerous list to starboard, where she lay nearly entirely submerged.



CANNERY SHIP JABEZ HOWES, WRECKED AT CHIGNIK, ALASKA.

The San Francisco Board of Marine Underwriters has sent to the scene of the accident Capt. E. C. Genereaux, one of its surveyors, to supervise the work of salvage. He was accompanied by a diver and ample gear to do everything possible to save the freight carried by the Howes. This includes everything needed in a cannery, such as provisions, clothing, tin, lead, zinc, acid, lumber, piling, gasoline, netting and other necessities. None of the cargo had been discharged when the accident occurred. The photograph shows in what a precarious position the Jabez Howes lay and confirms the later reports that the vessel will be a total loss. The first reports stated that it would be necessary to drive piling around the hull to prevent its being broken up before the cargo was taken out and in the photograph the pile-driver is shown alongside. However, advices from Capt. Genereaux are to the effect that the vessel's masts have been cut off to prevent the hull taking a more dangerous list. The report also stated that it might be necessary to dynamite the hull to enable the salvers to take out the piling. It is believed that a considerable portion of the cargo will be saved.

The Jabez Howes was one of the few remaining wooden American square-riggers which 30 years ago were the pride of this country. She was built at Newburyport, Mass., in 1875. The ship was worth not to exceed $20,000 and it is understood that she was uninsured. The cargo's value was $90,000 and was insured in the San Francisco market. The owners of the Howes have since purchased the wooden ship Reuce and sent her to Chignik, which is 400 miles west of Seward, Alaska. The inaccessibility of Chignik has rendered salvage operations very difficult.

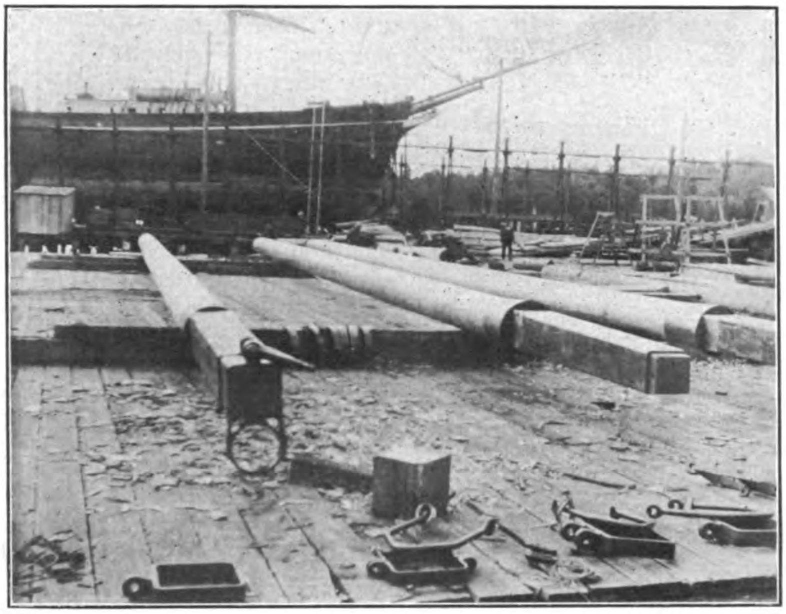
In the last five years, the underwriters have suffered some very heavy losses on the Alaska cannery fleet. Since 1907, among the ships lost have been the John Currier, Lucile, Star of Bengal, Columbia and Jabez Howes. The first three named entailed losses of about $300,000, each as they were laden with the season's pack of canned salmon. Owing to numerous disasters in the north, insurance rates on cargo have been raised until they reached 3 per cent in 1910. The same rate is in force this year. On hulls, the rate is, naturally, much higher.

The Timbers of Puget Sound

In the accompanying illustration is given an idea of the size of the great timbers to be found in the forests adjacent to Puget Sound. These immense sticks are sometimes jocularly referred to as toothpicks. This photograph was taken at the yards of Hall Brothers Marine Railway & Ship Building Co., Winslow, Wash.

The three sticks shown in the picture are the main, mizzen and spanker masts for the dismasted wooden schooner Willis A. Holden, which was damaged in the North Pacific. These masts are each 110 ft. 2 in. in length. The diameter of the main mast is 25 in., that of the mizzen 24¾ in. and of the spanker 23½ in. Each stick required one of Puget Sound's immense fir trees, which is the best wood in this section combining the maximum of strength with the minimum of weight. The log from which the mainmast was made was 112 ft. long, with diameter of 5 ft. at the butt and 36 in. in diameter 56 ft. from the butt. The mizzen mast came from a log 112 ft. long and 32 in. in diameter at the center, while the spanker was made from a log 118 ft. in length, 32 in center and a diameter of 22 in. at the top.

It requires the skill and judgment of experienced woodsmen to select and fell trees for this purpose. The tree in addition to being a certain length and diameter must be as straight as a string and it must turn out clear, select timber, for second grade wood, filled with knots and pitch, will not be accepted for ship's spars. After the tree is picked, extreme care must be exercised in felling it so as not to damage or break



MASTS 110 FT. 2 IN. LONG FOR SCHOONER WILLIS A. HOLDEN AT EAGLE HARBOR, WASH.

it. These masts came from the great forests skirting the waters of upper Puget Sound in Mason county, Washington, where lies the best timber in this part of the country. Probably no other section of the United States contains so many large trees and such extensive forests as does this region. From the forest, the big trees for these masts were hauled to tidewater by steel cables and donkey engines. Then they were rafted to the shipyards. Upon being delivered there and before a bit of work was done on them, the value of each of these big logs was approximately $150.

In addition to the big lower masts shown in the photograph, four topmasts are being prepared for the same vessel at this yard. These also are hewed by hand from select trees but are much smaller. The dimensions are 54 ft. 6 in. in length. Then there are three booms, each 41 ft. long, 10¼ in. at one end, 9 in. diameter at the other and 12 in center, being made in addition to the spanker boom, which is 62 ft. 8 in. in length, 14 in. diameter in center, 9½ in. at one end and 9 in. at the other. The rest of the equipment includes four large gaffs.

The work of hewing these splendid sticks to the desired shape and size is done entirely by hand with ax and drawknife. It requires skilled workmen to do this as the slightest mistake will ruin a valuable piece of wood. The fifteen sticks for this schooner were completed in thirteen days by six men from the rough logs. This is said to be a record for the Pacific coast. The topmasts weigh each about 1,500 lbs. while each of the lower masts weighs 5½ tons. Ready to step into the vessel, each of the lower masts shown in the picture is valued at $500.

When the Willis A. Holden was damaged in a terrific storm off this coast, she was stripped of all her masts and spars but the fore lower mast. With sail attached to this, she was steered into San Francisco, a distance of 800 miles. It is remarkable that when the tons and tons of masts, booms and rigging tumbled to the deck, neither the hull was damaged nor was any of the crew injured. By a strange freak, the vessel freed herself of this mass of wreckage within 15 minutes. It is usually the case in accidents of this kind that the rigging holds the broken spars alongside, endangering the crippled vessel.

Big timbers from Puget Sound are shipped to all parts of the world. Many cargoes have been sent to the Atlantic coast during the last few years where considerable demand exists for masts and spars. Not a few schooners on the Atlantic are carrying their sails on masts felled in the great forests of Puget Sound. There is also a demand in Japan for these big logs. In the Orient, however, the Japanese saw these logs into lumber in their own mills. Experience has taught them that it is good business to purchase the rough logs in large sizes and saw them to the desired dimensions in preference to buying the manufactured product on this side.

Engine for Using Heavy Oil

An invention that is expected to attract attention from those who desire an economical and simple engine using heavy oil, has been designed by A. G. Pace, of Seattle, formerly connected with the Moran Co. He furnishes the following description of the engine:

The engine is a four-cycle, two-cylinder, 6½ in. bore by 8 in. stroke, heavy-duty marine motor, running at 400 r. p. m. This engine has been tested and found to develop 20 b. h. p. on a consumption of 1¼ gals. of gas oil per hour and 2½ gals. of fresh water. The cycle is a new one and operates as follows: The engine is provided with a double carburetor, one side having gasoline for starting and the other side gas oil (26 Baume), the gas oil being pumped up to the carburetors by a small pump driven from the cam shaft. A special cock is arranged so the motor may be thrown from the gasoline to gas oil while running.

It was found to take about five minutes to warm the motors sufficient to allow the use of gas oil.

A means is also provided to introduce fresh water into the exhaust pipe close to the exhaust valves.

The inlet valve is held open only for about half the stroke and just previous to the closing of the inlet valve the exhaust valve begins to open during the suction stroke and the cylinder filled with exhaust gases and steam giving a slight pressure at the beginning of the compression stroke.

Upon compression the motors are fired in the usual manner with a make-and-break spark, the current being provided by a Bosch low-tension magneto.

The motor burns the mixture with a blue flame, the same as in the regular gasoline engines, and the speed may be varied within wide limits, the motor being extremely flexible.

It can be readily seen that by introducing the exhaust gas and steam, the temperature of the exhaust is reduced sufficiently not to cause ignition.

Upon compression the exhaust gases are mixed with the heavy oil, which is practically taken in in the form of spray and vaporizes the oil within the cylinder in practically the same manner as used in some of the most successful retorts.

It is well known that the ordinary gasoline motor works at a ratio of 16 parts of air to one of gas, but according to Guldner, a mixture of 45 parts air to one of gas may be exploded with practically the same power, provided it could be gotten into the cylinder, but owing to the presence of exhaust gases in the compression space of the motor it is impossible to get such a lean

mixture in, as all lean mixtures fire readily by the remaining exhaust gases commonly called back-firing.

Also there is an excess of 60 per cent of air required to burn the oil properly in the regular four-cycle motor.

It has been found that with the regular four-cycle gasoline motor as small as 8 h. p., 13 per cent of the fuel passes to the exhaust pipe unburned.

Therefore, it is possible to dilute the mixture to a considerable extent.

In fact, the oil engine today shows but 20 per cent efficiency while the best gas engine shows close to 35 per cent efficiency.

The motor was run with the jackets hot and then warm and then cold, and it was found to make practically no difference in the operation of the motor, and if anything, the motor worked better with the jackets cold.

Another noticeable feature was, the exhaust pipe did not get half as hot as with the regular Otto cycle, in fact the exhaust pipe on this motor was provided with a water jacket and during the experimenting the water jacket was cut out, the exhaust pipe being sufficiently cool without it. This may be accounted for by the fact that practically half the oil or heat units was used, and in consequence less heat to be dissipated.

Those familiar with the Diesel engine know that the motor shows an economy equal to it without its attending disadvantages of high compression some 600 lbs. and its 800 lbs. of air required to blow the fuel in.

In the two-cycle Diesel engine, two extra cylinders have to be provided, one scavenger and one two-stage air compressor, to assist the four working cylinders, to say nothing of the auxiliary engine to provide means for starting.

I believe I may justly claim that I can build my engine, power for power, for half the money.

Producer Gas Installation in Barkentine Archer

SEATTLE, June 5.—What is said to be the first marine producer gas plant installed on the Pacific coast is now being placed in the 900-ton, three-masted iron barkentine Archer, 185 ft. long and 32 ft. beam. The Archer is owned by the Tacoma & Roche Harbor Lime Co., of Roche Harbor, Washington, and is used in freighting lime in barrels between the quarry and kiln at Roche Harbor to San Francisco. The installation is being made by the Seattle Gas Engine Machinery Co. under the supervision of A. Howard Cox, of that company, and Peter G. Schmidt, of the Schmidt Gas Power Co. The vessel is lying at Eagle Harbor, Wash., where the work is being done.

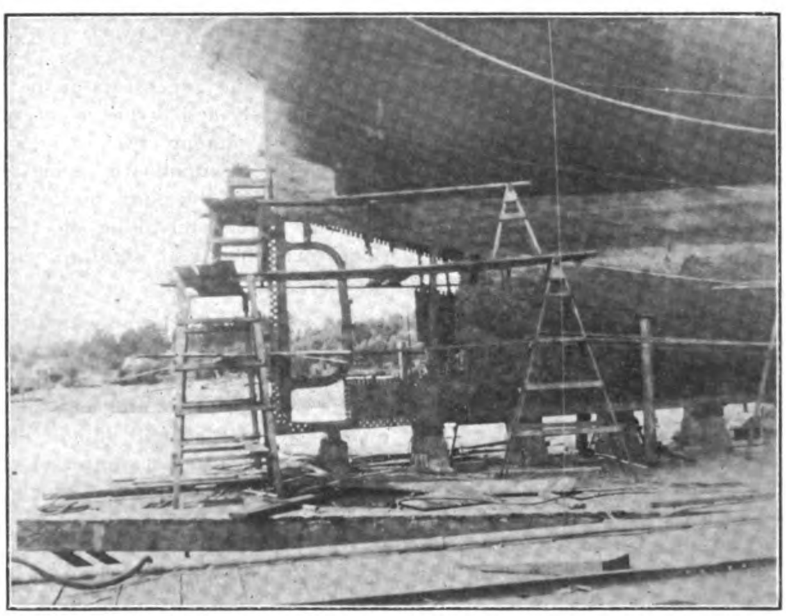
In addition to having the largest single unit marine producer gas installation, the Archer will be fitted with what is claimed to be the largest reversible propeller ever built. This was designed by L. H. Coolidge, of this city. It is 82 inches in diameter and constructed throughout of Spare's manganese bronze. It is of the feathering blade type and reverse is accomplished by moving ahe blades fore and aft. The reverse of the propeller and the operation of the clutch are accomplished by pneumatic cylinders, the reverse cylinders being controlled by oil dash-pots with valve regulated by-pass to render the travel of the blades smooth and uniform and prevent the back-lash when the blades go from ahead or astern position to center. The travel of air cylinders controlling clutch is cushioned pneumatically at the end of stroke. The control of the pneumatic cylinders is effected by two levers similar to a street car controller, which are brought up through a column bolted to engine floor, the handles moving in a horizontal position and the engine speed regulation accomplished by a variable speed governor, controlled by a separate lever mounted on the engine and brought to a point in proximity to the pneumatic control.

The main engine is a 300-H. P. Nash engine, built by the National Meter Co., New York City. It is a four-cylinder type with cylinders 18 x 18, operating at a speed of 200 R. P. M. on producer gas. The weight of the engine is 80,500 lbs. A 500-H. P. Akron friction clutch is mounted directly upon the transmission end of engine shaft, which is connected to the thrust shaft.

The diameter of the tail shaft is 6¾ in. and the movable sleeve for the propeller mounted on same has an external diameter of 7¼ in. A bronze bushing is mounted over the sleeve, having an external diameter of 8¾ in. which furnishes the bearing surface of the tailshaft and is intended to prevent wear on the reversing sleeve. The bearing sleeve is a bronze casting which can be removed in case of wear.

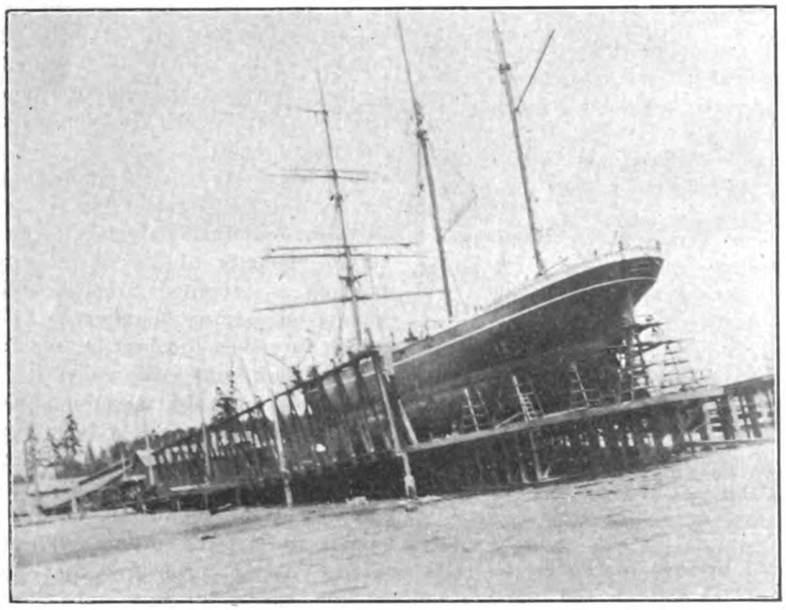
Water tight bulkheads enclose the engine room, the after bulkhead at Frame No. 3 furnishing the support of inboard end of stern tube and forward bulkhead will be located at frame No. 20.

The producer is designed and built by the Schmidt Gas Power Co. and is of 400-H. P. capacity. It will be installed forward of the bulkhead and a housing installed between frames 19 and 27 about the lower deck level.



BARKENTINE ARCHER BEING ALTERED FOR MARINE GAS PRODUCER INSTALLATION AT EAGLE HARBOR, WASH.

The producer is 9 ft. in diameter and 10 ft. in height. It is of the updraft type, designed to handle the lowest grade of lignite, which costs in this section less than $1 per ton at the mine and from $1.70 to $2 per ton delivered at tidewater. It is expected to use the pea size on the Archer. The coal will be fed through four hoppers on the top of producer for the purpose of getting a uniform distribution of fuel. Two gas washers will also be installed on the working platform, one being used for auxiliary and only one being operated at a time. This gas washer is one of the vital units of the producer installation and has made the producer a success on the low grade fuels to be used, as the gas washer leaves in the gas only one-seventh of the impurities allowable by the American Society of Mechanical Engineers.



BARKENTINE ARCHER IN DOCK AT EAGLE HARBOR, WASH.

Storage for coal is provided between the main deck and poop deck from the sides of the producer housing to the sides of the vessel. Fuel will also be carried from the working platform to the top of producer. An additional supply of coal will be stored between decks, over the engine, being sacked and passed forward through the hatch just above the ladder. More coal will be carried on the decks. On this vessel space is very valuable for cargo and it has been impossible to install bunkers of any size in the available space of the ship. Space of no value for cargo has had to be utilized for storing fuel.

The Archer will carry a rather pretentious auxiliary equipment including a 17-kilowatt, 110-volt D. C. Westinghouse inter-pole generator hung from the ceiling and belt-driven from the main engine fly-wheel. This generator is designed to operate through a variation of speed on the engine flywheel from 225 R. P. M. to 150 R. P. M. and maintain 110 volts. In the event the engine is run at a slower speed than 150 R. P. M., the electrical supply for the various motor-driven machines will be furnished by a Nash 12-kilowatt direct-connected distillate engine and Sprague generator. A further auxiliary for supplying illumination for the vessel and operating the wireless telegraph set, will be furnished by a Brush 5-kilowatt direct-connected set, which is built by the C. A. Strelinger Co. of Detroit. These three generating sets are controlled on panel of the switchboard allowing any two of the generators to be used simultaneously and divide in any manner desired among the various circuits. The switchboard consists of six panels of Vermont marble, each 1 ft. by 5 ft., controlling all the various machines and lighting circuits aboard.

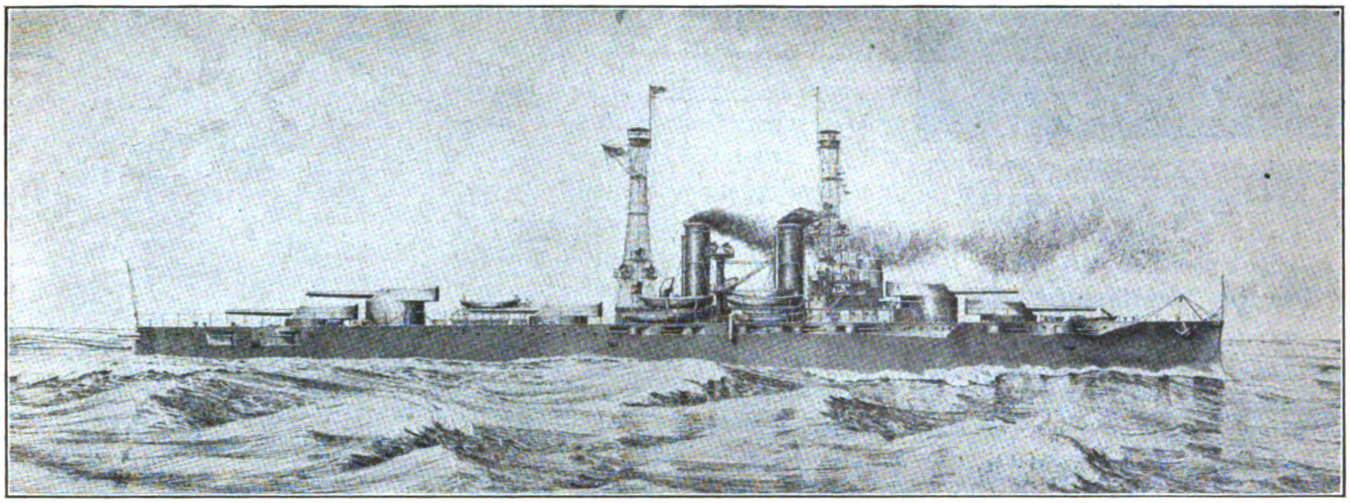
For operating the pneumatic reverse and clutch, the Lunkenheimer whistle and the starting of the main engine, compressed air will be furnished by a Blaisdell duplex 4 x 5 self-oiling enclosed compressor, gear driven by Westinghouse motor. The air receivers for the compressor will be two Blaisdell cylindrical tanks 30 in. in diameter by 8 ft. in length designed for pressure of 150 lbs. By means of a Sundh pressure regulator and motor starter on an individual panel, the air pressure will be maintained at the desired point. This pressure regulator is designed to start the motor when the air pressure falls to a determined point and stop the motor when the pressure has reached the desired amount, thus making the air pressure automatic.

To handle bilge water and also for supplying water through sea connection for washing decks and for fire protection, a motor-driven bilge pump will also be installed. A direct connected centrifugal pump operated by a 2-H. P. G. E. motor will furnish water supply for the producer gas washer, etc., and can also be used for auxiliary engine circulation in case of accident to the main engine circulating pump. The water supply will be brought in through a 4-in. Liberty twin strainer.

In the engine room a work bench will be provided with all necessary tools which the space will afford for making repairs. There will also be a locker for material and spare parts. A full supply of spare parts for all the machines will be carried, enabling repairs to be made to any ordinary breakage without delay. The engine room will be ventilated by natural draft ventilators and both engine room and producer gas room will be further ventilated by an exhaust fan in each.

To facilitate loading and discharging at Roche Harbor and San Francisco respectively, a barrel elevator will be installed, with a capacity of 800 barrels an hour. This contrivance will likely be furnished by the Meese & Gottfried Co., of Seattle and San Francisco. It is further planned operating a conveyor on the dock at Roche Harbor to receive the barrels as they reach tidewater and carry them to a storage warehouse about 500 ft. distant. When loading the vessel, the operation will be reversed, the barrels placed on the conveyor and discharged into the vessel's hold about 500 ft. distant.

Extensive cleaning is necessary after each voyage, as the vessel's holds and decks are littered with lime dust and parts of broken barrels. In order to properly clean the ship, an 8-in. pipe line will be run the length of the vessel in the main hold, connected with an exhaust fan, discharging over the side of the ship into the water. At convenient points slide openings will be arranged into which an 8-inch flexible pipe may be inserted, having a nozzle at the free end, with which the interior of the ship will be thoroughly flushed after each cargo is discharged.



SKETCH OF THE BATTLESHIPS NEW YORK AND TEXAS AS THEY WILL APPEAR WHEN COMPLETED

Drawing furnished by the Navy Department.

It is important that the vessel's owners know her location, her condition and the exact time of her arrival, so a 5-k. w. wireless set of the 500 cycle quench spark type has been installed. This has been found to work very satisfactorily, giving the vessel a range of about 1,000 miles at night. This wireless apparatus is of extreme importance in working the Archer with economy as when the exact time of her arrival is known, it is possible to have a cargo ready and to get it loaded with the minimum of delay. In this connection, the labor of stowing the vessel can be done without overtime.

From the standpoint of economy, the expenditure now being made on the Archer is expected to be a good investment. The total cost of the installation, including necessary alterations to the stern to take propeller, is estimated at about $35,000. However, it is figured that with the vessel's increased earning capacity, this will be repaid in not to exceed two years. With power, the Archer is expected to make a round trip between Roche Harbor and San Francisco in two and one half weeks, including loading and discharging. At this rate she will average more than twice as many trips per year as in the past, thereby showing returns on the investment equal to two vessels of the same size but with the operating expenses of only one. Towage charges for this vessel, as she now stands, amount to between $5,000 and $6,000 per annum. This will be a direct saving. It is estimated that the Archer will consume six tons of coal per day of continuous running or an average of 65 tons of coal per trip, with engines constantly operating. With fuel at $2 per ton, this expense is figured at $130 per voyage. As the engineer operating the marine engine will also be able to run the steam winch for handling cargo, already installed, the present steam engineer can be dispensed with and therefore the crew will not be increased. The producer operates entirely on salt water and to prevent fire, due to moisture acting upon the cargo of lime, it is contemplated piping the exhaust of engine into the lime hold with a valve connection, enabling the filling of the entire hold with carbonic acid gas from the engine discharge, should fire break out.

Battleships New York and Texas

The plans and specifications for first class battleships No. 34, New York, and No. 35, Texas, authorized by act of congress approved June 24, 1910, were completed and circular signed by the acting secretary of the navy, Sept. 27, 1910, and issued to the bidders upon request thereafter.

The general dimensions and features of each vessel are as follows:

Length on designer's water line	565 ft.
Breadth, extreme, at designer's water line	95 ft. 2⅛ in.
Mean trial displacement	27,000 tons
Mean draught to bottom of keel at trial displacement (about)	28 ft. 6 in.
Total coal bunker capacity (about)	2,850 tons
Coal and fuel oil carried on trial	2,167 tons
Feed water carried on trial	213 tons
Speed on trial, not less than	21 knots

ARMAMENT.

Main Battery—Ten 14-inch 45-caliber breech-loading rifles; four submerged torpedo tubes.

Secondary Battery—Twenty-one 5-inch rapid-fire guns; four three-pounder guns for saluting; two one-pounder guns for boats; two 3-inch field pieces; two 30-caliber machine guns.

Bids for the construction of the Texas were opened at the department, Dec. 1, 1910, and the contract awarded on Dec. 17, 1910, to the Newport News Ship Building & Dry Dock Co., Newport News, Va., at a price of $5,830,000, to have the contractor's design of reciprocating machinery installed; the vessel to be completed on or before the expiration of 36 months from the date of signing the contract. The contract for the Texas was signed Dec. 17, 1910.

The New York will be built at the navy yard, New York, N. Y.

Personal

William T. Nevins has removed his office from 317 Royal Insurance building to 1740 Monadnock building, Chicago, where he will carry on the business of naval architect and surveyor.

The Hamburg-American Steamship Co. has given orders for the construction of a sister ship to the mammoth steamer Imperator, now building. The new vessel will be 890 ft. long and will be placed in the New York service. She will be equipped with four Parsons turbines and 46 Thornycroft water-tube boilers. She will have three funnels, two for boiler draft and one solely for ventilation.

The Fore River Ship Building Co., Quincy, Mass., will launch the first of the two 28,000-ton battleships it is building for the Argentine Republic, on July 27.

The navy department will open bids, on Aug. 7, for eight torpedo boat destroyers, authorized by congress to cost $825,000 each.

The navy department will open bids on June 20 for the construction of four fleet colliers and two seagoing tugs.

THE MARINE REVIEW

DEVOTED TO EVERYTHING AND EVERY INTEREST CONNECTED OR ASSOCIATED WITH MARINE MATTERS ON THE FACE OF THE EARTH.

Published monthly by

Penton Publishing Co.

PENTON BUILDING

CLEVELAND.

CHICAGO..............1328 Monadnock Blk.
CINCINNATI.......808 Provident Bank Bldg.
NEW YORK....Room 1115 West Street Bldg.
PITTSBURG............2148-49 Oliver Bldg.

Correspondence on Marine Engineering, Ship Building and Shipping Subjects Solicited.

Subscription, U. S. and Mexico, $1.00 per annum. Canada, $1.50. Foreign, $2.00.
Single copies, U. S. and Mexico, 10 cents. Elsewhere, 15 cents. Back numbers over three months, 25 cents.

Change of advertising copy must reach this office on or before the first of each month.

The Cleveland News Co. will supply the trade with THE MARINE REVIEW through the regular channels of the American News Co.

European Agents, The International News Company, Breams Building, Chancery Lane, London, E. C., England.

Entered at the Post Office at Cleveland, Ohio, as Second Class Matter.

June, 1911

On with the Investigation

These be the days of probes, investigations and inquiries at Washington and at sundry state capitols as well and the corporation or business which is big enough to be nationally prominent and escapes at least suspicion is fortunate indeed. Much of this inquisitiveness appears, however, to be due to the non-participation in the benefits and emoluments accruing from the crimes and offenses complained of or suspected. With all the sterling, rugged honesty, patriotic zeal and burning desire to put down crookedness in high places, now manifesting themselves in various quarters where their presence has heretofore been unnoticed and even unsuspected, it is passing strange that the navy department, the greatest bunko game of them all with its banners and bluff; guns and graft; formality and falsehood; imposing, noisy front and yellow fear within, goes its way unhindered.

Its very boldness and self-assurance and its long and powerfully entrenched position seem to insure it immunity from examination and yet while railroads, certain lines of manufacture, public service corporations and others have come under review, all of these do render something in return for the money they collect; the navy returns nothing but jobs for a few officers, educated also at the expense of the public, for whom they have nothing but contempt, though, as now appears, many of them are themselves beneath it.

THE MARINE REVIEW has, month after month, made charges which, if unsupportable, would have long since been attacked and exploded. But with the exception of two or three magazine articles from interested but unofficial sources and with which we have previously dealt, no attempt has been made at denial. In fact, many of them have been admitted, some openly and more tacitly.

Even Secretary Meyer was himself caught in the act of attempting to deliberately mislead the house naval committee, as the proceedings of congress show. His friends who contributed freely to popular magazines also attempted deliberately to mislead the public by misquoting figures pointed out in the March REVIEW. There has been nothing but prevarication, evasion and mis-statements from the department since Meyer took office.

In one respect Secretary Meyer has made a point of yielding to the pressure for reform by employing Messrs. Emerson and Gantt to institute modern scientific methods in the navy yard shops. Mr. Meyer did this undoubtedly because he or his aids feared the appointment of such a commission as advocated by the REVIEW and of the unsavory facts it would uncover, many of which are well known and commonly discussed in every engineering and ship building plant in the country.

It is unfortunate that all the inner facts of the miserable coal deal could not be exposed. We have stated over and over again that this subject would not stand the light and that reputations would be blasted if it were investigated. The department was driven to desperation by the attacks from all sides on this subject and the ludicrous arguments and pitiable falsehoods to which it resorted in defense have passed into history.

There is plenty left for an investigating commission such as we suggested, to work upon. The expenditures for dry docks and equipment as we have pointed out bear evidence of incompetence, extravagance and we believe, in some cases already noted, worse than these. The expenditures for fleet colliers are extravagant and unnecessary and the figures quoted as to their work are not the truth. Where did the money go for the Vestal and Prometheus, two colliers to carry 6,000 tons each and costing over a million and a half each, and which were over five years building and of which one, the Prometheus, has only once been to sea and both of which the general board, with Admiral Dewey at its head, has advised be converted into supply ships as soon as possible?

For what do departmental estimates provide when enormous sums are asked for construction in navy yards

and the same ships can be contracted for in private yards at one-third less, in spite of overhead and operating charges and profits from which the navy yards are free?

Take the Utah and Florida, for instance. Add to the latter's apparent cost the same charges carried by the Utah and her cost would be nearer double the Utah's than anything else. Look at the department estimates of $3,600,000 for two colliers of 14 knots speed and 12,500 tons capacity, one to be built in a navy yard. The other was contracted for and built and delivered for $822,500, considerably less than half the appropriation. This ship, the Cyclops, was fully described in the January REVIEW. Nobody believes any such disproportion exists honestly.

The navy has no business in the coal carrying trade and the excuses for the building of colliers are merely moonshine. Why don't other navies need them as well as ours? If our own navy was half as much interested in the upbuilding of a merchant marine as it is in creating and gratifying fads it would not want for ships to handle its coal. The department needs fumigating and it will never be any different until the system is rooted out.

The REVIEW here takes the opportunity of saying that its reference to "line officers" in earlier articles must not be understood to be sweeping. We take pleasure in testifying to the sterling qualities of numbers of line officers of all ranks whom to know is an honor. They are not among those who are so fond of talking of the "fighting officers" but who are chiefly occupied in scrambling for the soft shore billets. They are of those whose record is full of deeds and work and study instead of words; kindly, but fearless and unshirking; gentle of speech and unobtrusive in manner but adamantine in discipline and full of sea experience and practical knowledge.

We count with pride many such among our friends and none more sincerely deplore the low state into which the service has fallen. One of these, who has served his full allotted period of life and reached the highest rank attainable in the service, except the honorary rank held only by Admiral Dewey, and most of whose years have been spent at sea, says that no one outside the service itself can have any idea of the subjection under which officers now live. The secretary is completely dominated by a few in Washington who impress upon him their own narrow ideas and persuade him to a stand, to question which or from which to endeavor to move him is rank treason. Those of any grade, high or low, who do not fall into line and applaud are banished from all desirable duty or distinguished commands and as a result the body is either cowed into acquiescence or forced to join with those in the ascendant. For proof that the officer referred to speaks the truth it is only necessary to take a look at the list of those who have ventured to say a word on the other side and note what has happened to them.

The secretary as things stand never hears the voice of the navy. He hears a noise made by a few and is too obstinate, too easily influenced and too lacking in perception and information to recognize that a public opinion exists in the navy. The navy is muzzled by the knowledge that punishment awaits any member who dares say what he thinks is not in line with the ideas of those who have the secretary's ear. Until the navy regulations invite officers to discuss, over their own signatures, matters not confidential and they are assured of immunity for decorous speech this condition will continue and the same old game will go on. The people and their treasury will be plundered and a few swaggerers will fill the public eye and the public press while those remote will not even get a hearing. The secretary and the president see only such papers as the coterie wishes them to see; the others are kept from them and they are only permitted to know one side of any question.

Says another officer of long experience in both sea and administrative duty:

"As to the conditions of navy yard work you can't hit too hard. If your statements are wrong your arguments will be weakened; if right, reform will be introduced just so much sooner. The taxpayer has the right to demand that every penny of the naval appropriation shall produce its equivalent in good work or good material and not a penny be wasted."

The service is responsible for millions wasted every year for political ends and for millions more lost through stubbornly wrong-headed or criminally ignorant methods and lack of skilled, well supported management, and still more millions for the appropriation of which there is no justification whatever.

Let us have the investigation, full, free and without fear or favor. No one is so much afraid of it as the department.

Campaign for Pure Water

The Niagara Frontier Pure Water Conference has started a campaign for purer water and has compiled some statistics that certainly are worthy of grave consideration. These statistics have to do with the increase of typhoid fever in lake cities. During 1909 there were 922 cases of typhoid fever in lake cities and 1,074 cases in 1910. The increase in Lake Superior cities was particularly marked, being 55 in 1909, and 112 in 1910, and Lake Superior water is considered to be the purest.

The argument of the conference is that the Niagara frontier gets all the polluted water of the lakes and will continue to get it until some other means is employed of disposing of sewage. It declares that the state of New York is maintaining in Niagara Falls a death trap that is a disgrace to the state and nation. It allows a million of visitors a year from all over the world to visit the falls and drink the water without warning them that it is not fit to drink. Dr. Eugene H. Porter, state health commissioner, reports that it is so bad that it is not even safe to put into the mouth, much less to swallow. It has been suggested that the subject is worthy of investigation by a body of sanitary

engineers of the United States government, the Russell Sage Foundation or the Carnegie Institute.

An Excellent Engine Record

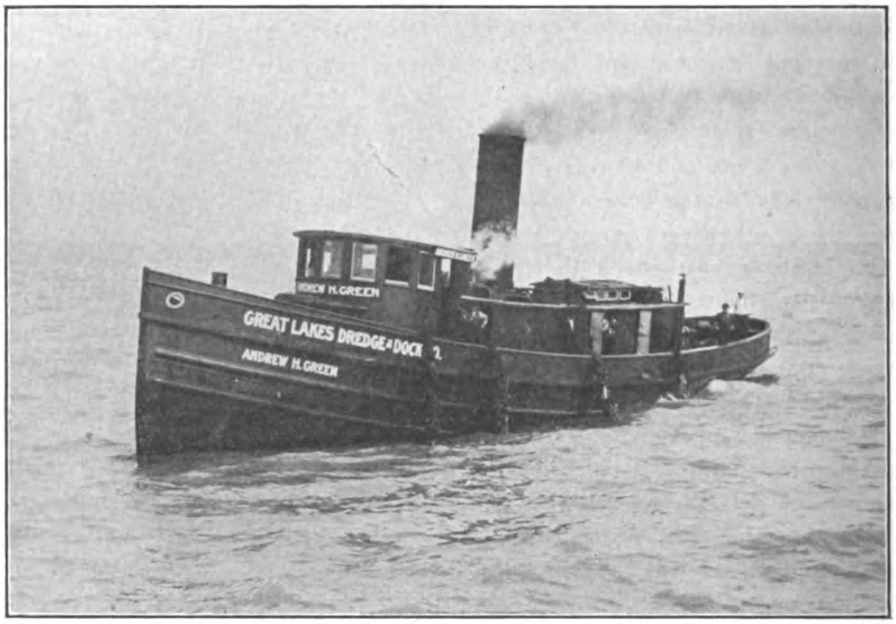
What has proved to be one of the most successful marine installations on the Great Lakes is the 7,000-h. p. engine on the Detroit & Cleveland Navigation Co.'s steamer, City of Cleveland. During the three seasons in which this steamer has been in commission, the propelling machinery has not caused the steamer a moment's delay, and the repair bill on the same is reported as being absolutely nothing, which speaks well for the design, materials, workmanship and the intelligent care in operating.

This is the more striking when it is remembered that this engine is somewhat novel in design, owing to the unusual combination of valve gears, which necessarily entailed greater complication of detail than is usual on marine engines. Designed for service between Cleveland and Detroit, the difference in speed desired for day and night trips called for an engine which would be efficient through a greater variation of power than is practicable with the range of "cut-off" possible in ordinary link motion gears.

The engine is of the three-cylinder, compound inclined type, having one high-pressure cylinder, 54 in. diameter, and two low-pressure cylinders, 82 in. diameter, with a piston stroke of 96 in. All valve gears are of the "releasing" type, the high-pressure cylinder being fitted with double beat poppet valves and oil dash pots, while the low-pressure cylinders have "Corliss" gear with the usual vacuum dash pots, the range of "cut-off" being from one-fourth to three-quarters of the stroke in each case. With this gear it is possible also to distribute the total horsepower so that each cylinder will develop one-third, a most desirable feature which is impossible with the ordinary arrangement of valve gear.

Along with its remarkably smooth running the engine has shown a high steam economy and so well is the design thought of that it will be repeated in its entirety in the 9,000-h. p. engine, being built by the Detroit Ship Building Co. for the new D. & C. steamer, now under construction by them, which will be placed in commission in the summer of 1912.

Steel Tug Andrew H. Green



STEEL TUG ANDREW H. GREEN.

Johnston Bros., Ferrysburg, Mich., recently delivered the tug Andrew H. Green to the Great Lakes Dredge & Dock Co. of Chicago. The tug is of steel, 92 ft. long on deck, 21 ft. beam and 12 ft. molded depth. The engine is a fore and aft compound with cylinders 16 and 34 in. diameter by 26-in. stroke, supplied with steam from a firebox marine boiler 10 ft. diameter and 14 ft. long, allowed 165 lbs. pressure. The tug is equipped with a Providence steam towing machine.

Carrying Test of Steamers Palmer and Olcott

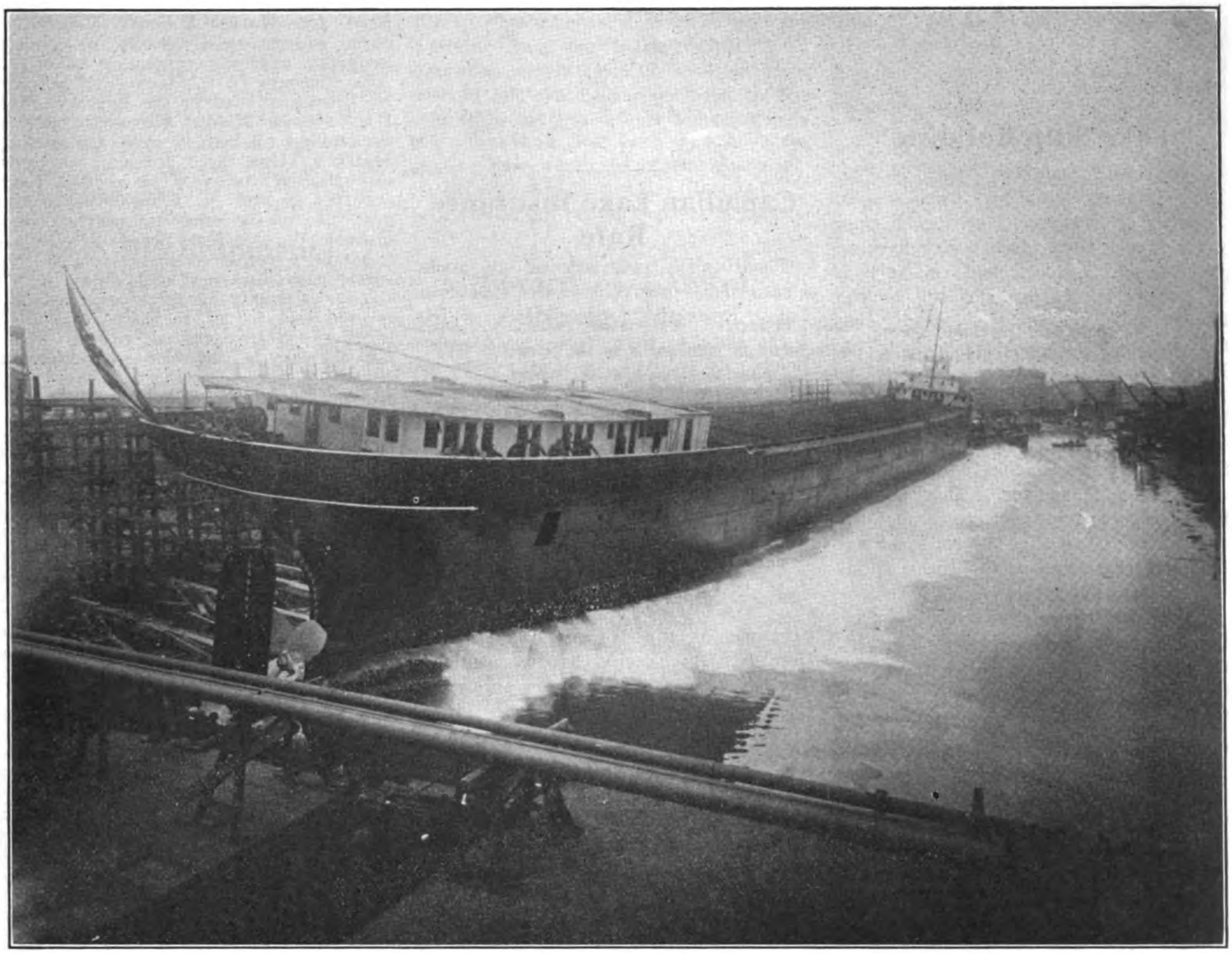
During the early part of May the Pittsburg Steamship Co. tested out the carrying capacities of the steamers William P. Palmer and W. J. Olcott. Both of these vessels are of identical proportions and were both constructed at the Ecorse yard of the Great Lakes Engineering Works. The Palmer, however, is built upon the Isherwood or longitudinal system of construction and the test was made to prove the claim of the designers that the Palmer would carry more than the Olcott under equal conditions. Both freighters loaded the same grade of ore and took aboard the same amount of fuel. The Palmer unloaded at the Pittsburg & Conneaut Co.'s dock at Conneaut, drawing 18 ft. forward, 18 ft. 2 in. amidships and 18 ft. 4 in. aft. The bill of lading weight of the Palmer's cargo was 10,359 tons and the weighing out weight 10,386 tons.

The Olcott unloaded at the Superior dock at Ashtabula, drawing 18 ft. 1 in. forward, 18 ft. 1 in. amidships and 18 ft. 3½ in. aft. Her bill of lading weight of cargo was 10,085 tons and the weighing out weight 10,134 tons. The difference in these weights, of course, is due to the arbitrary subtraction of 1 per cent for moisture in the bill of lading weight. The Palmer, according to the bill of lading weight, carried 274 tons more than the Olcott and according to the weighing out weight 252 more tons. Results are tabulated as follows:

Steamer	Bill of lading weight, gross tons.	Weighing out weight, gross tons.	Draught, forward.	Draught, amidship.	Draught, aft.
Palmer ...	10,359	10,386	18	18.2	18.4
Olcott	10,085	10,134	18.1	18.1	18.3½

Steamer Perfection Launched

The steamer Perfection was launched from the Cleveland yard of the American Ship Building Co. for the Standard Oil Co. on May 21. The Perfection is the first of seven vessels building for the Standard Oil Co. to be launched. The American Ship Building Co. is building two steamers and two barges at its Cleveland yard for this company and three barges at the Lorain yard. The Perfection is 260 ft. over all, 250 ft. keel, 43 ft. beam and 23 ft. deep, equipped with triple-expansion engines with cylinders 19, 31 and 54 in. diameters by 42-in. stroke, supplied with steam from two Scotch boilers, 14½ ft. diameter and 11½ ft. long, allowed 200 lbs. pressure. All of the seven vessels will go into commission during the present season and it is expected that the Standard Oil Co. will let contract for a large steamer for lake service during the fall. It is intended that the seven vessels now building on the lakes will go to the coast in the fall.



LAUNCHING THE STEAMER QUINCY A. SHAW FROM THE LORAIN YARD OF THE AMERICAN SHIP BUILDING CO.

Launching the Quincy A. Shaw

The steamer Quincy A. Shaw, building for M. A. Hanna & Co., was launched from the Lorain yard of the American Ship Building Co. on May 17th, being christened by Mrs. Max McMurray, wife of the superintendent of furnaces for M. A. Hanna & Co. The Shaw is building on the Isherwood or longitudinal system of construction and is the first boat of that type to be built by the American Ship Building Co., though the Great Lakes Engineering Works of Detroit had already built the William P. Palmer upon that system. The launching was distinguished by the presence of J. W. Isherwood in person. Mr. Isherwood could not be present at the launching of the Palmer but happened to be making a tour of the lakes on her at the time that the Shaw was ready to be launched.

It is claimed for this system of construction that it makes a lighter and a stronger ship and tests recently held between the Palmer and her sister ship, the W. J. Olcott, appear to bear out the claim. The Shaw is 524 ft. over all, 504 ft. keel, 54 ft. beam and 30 ft. deep.

The Shaw is the hundredth vessel to be constructed at the Lorain yard. Immediately preceding the launching of the Shaw four fish tugs, the Pittsburg, Philadelphia, Baltimore and New York, were sent overboard, making a record in the number of launchings for a single day in this yard. The tugs, however, are not counted to make the hundreth ship.

Steamer North West Burned

The steamer North West of the Northern Steamship Co.'s fleet was badly burned early Saturday morning, June 3, while lying in the Oklahoma slip of the Blackwell canal, Buffalo. The Northwest was practically fitted out for the coming season's trade and would have gone into commission on June 24. The fire was discovered about 4 o'clock in the morning by one of the watchmen and spread with such rapidity that before it could be extinguished the whole interior works of the vessel were practically destroyed. A preliminary survey made on her as she lies at the bottom of the Blackwell canal indicates that it will cost about $200,000 to repair her. The hull of the steamer was not much damaged and she will be taken to Cleveland for repairs. Her sister ship, the North Land, which was lying alongside, was slightly scorched, but the damages to her are not estimated as over $1,000. It will probably take three months to complete repairs upon the North West and as her season usually ends in September she will practically not be in commission at all this season.

No vessels ever built on the lakes attracted more attention than the North West and North Land when they came out. They resembled the ocean type rather than the lake type, having twin screws, quadruple engines and Belleville boilers with three stacks. Later the Bellevilles were taken out and Scotch boilers substituted and the stacks reduced to two. The North West is 383 ft. over all, 360 ft. be-

tween perpendiculars, 44 ft. molded breath, 26 ft. molded depth and 34 ft. 5 in. depth to the spar deck.

Lake Ship Building

The bulk freighter, Col. J. M. Schoonmaker, building for W. P. Snyder, of Pittsburg, at the Ecorse yard of the Great Lakes Engineering Works, will be launched on July 1. When she comes out she will be the largest freighter on the lakes, being 617 ft. over all, 597 ft. keel, 64 ft. beam and 33 ft. deep.

The new steamer building on the Isherwood system at the Lorain yard of the American Ship Building Co. for the Wisconsin Steel Co. will be named the Harvester. This is certainly a very appropriate name for this steamer, as the Wisconsin Steel Co. is the lake end of the International Harvester Co.

The Manitowoc Ship Building & Dry Dock Co., Manitowoc, Wis., launched a car ferry lighter for the Chicago River & Indiana Railroad Co., on May 13. The lighter is 190 ft. over all, 36 ft. beam and 8 ft. deep.

Antonio C. Pessano, president of the Great Lakes Engineering Works, has closed contract for two steel steamers for freight service on the Atlantic coast, making six steamers in all that this company is to turn out for coast interests. The new steamers are intended for general trade and will be 261 ft. long, 43½ ft. beam and 32.4 ft. deep. They will be equipped with triple-expansion engines and Scotch boilers, and following the usual coast practice, the machinery will be located amidships.

New Steamer Saguenay

The Richelieu & Ontario Navigation Co.'s steamer, Saguenay, is expected to reach this country from Glasgow during June. She is 275 ft. long, 56 ft. beam and 40 ft. deep to hurricane deck. The steamer has five decks in all, orlop, main, promenade, galley and hurricane. The machinery consists of two sets of triple-expansion engines, balanced on the Yarrow, Schlick & Tweedy system. Steam will be supplied by three single-ended multitubular boilers.

Tank Experiments for Shallow River Work

Prof. H. C. Sadler has just concluded in the experimental tank at Ann Arbor a long series of experiments upon different types of barges for shallow river work on behalf of a board of army engineers appointed to look into the question of river transportation. In all, Prof. Sadler tested out nine different types in three different depths of water and at two displacements. The models were tried not only singly, but in groups of six.

Canadian Lake Insurance Rate

The English underwriters have made a rate of 5¾ per cent to the Canadian Lake Protective Association, which is the same as that made to the Great Lakes Protective Association, being a reduction of ¼ of 1 per cent from the rate of the preceding year. The New York underwriters have given the Canadian association the English rate, of 5¾ per cent, while quoting a rate of 5½ per cent to the Great Lakes Protective Association. The Canadian association maintains that it is being discriminated against by the New York underwriters, under pressure of the Cleveland organization, but this seems hardly credible. The New York underwriters announce that full recognition will be given to the Canadian association as soon as it proves its ability to carry out its purposes.

Vessels Passing in the Rivers

Several costly accidents have occurred in the St. Clair river during the past three or four years and, of course, have had their influence upon the insurance rate. The Great Lakes Protective Association hopes to eliminate these accidents by removing the cause of them. Experience has shown that the most of them occur when one vessel tries to pass another, bound in the same direction, with the result that three vessels try to pass abreast. J. S. Ashley, chairman of the Great Lakes Protective Association, who has given his days and nights to the question of reducing the number of accidents, has sent a bulletin to vessel owners, recommending that their masters be directed to avoid this maneuver altogether. The bulletin follows:

After giving the matter much thought and after consultation with many masters, your Committee has concluded that it is a very dangerous proceeding for vessels to pass each other going in the same direction between the lower end of Port Huron Middle Ground and Corsica Shoals Lightship, also between the upper end of Russel Island and the lower end of St. Clair Flats Canal.

Three disastrous collisions have occurred in these localities within the last two years. In 1909, the steamers Geo. L. Craig and Cadillac were in collision at Southeast Bend, in which the Cadillac was sunk and which resulted in damage to both vessels amounting to nearly $20,000. In 1910, the steamers J. H. Reed and Martin Mullen collided opposite Joe Bedore's, resulting in damage to both vessels aggregating $110,000. Also steamers D. R. Hanna and Harvey H. Brown collided at the upper end of Port Huron Middle Ground, resulting in damage to both vessels aggregating $44,000. These three accidents are only examples of the very many that have occurred in the St. Clair river in the past five years, and in nearly every instance the accidents were directly attributable to three vessels passing or trying to pass abreast of each other.

Your Committee, therefore, strongly recommends to all members that they instruct their masters not to pass other boats going in the same direction in either of these localities. They also recommend to all owners that they instruct their masters that, when downbound, they check down to half speed between Corsica Shoals Lightship and the lower end of Port Huron Middle Ground, and also between the upper end of Russel Island and the lower end of St. Clair Flats Canal. This will enable them to take the sharp bends in better shape, and provided their vessels do not answer, will allow them to ring up full speed and thus make the vessel more readily answer her rudder.

Owners are also requested to again caution their masters as to using extra care in navigating all the rivers. Many complaints are being received of both up and down bound vessels holding too closely to the ranges, and thus not giving each other their proper share of the channel. This is a very dangerous custom and masters should again be cautioned that whenever meeting other vessels, they must keep well off the ranges and thus give each other plenty of room.

May Lake Levels

The United States lake survey reports the stages of the great lakes for the month of May, 1911, as follows:

Lakes.	Feet above tidewater, New York.
Superior	600.90
Michigan-Huron	579.70
Erie	571.87
Ontario	245.60

Lake Superior is 0.29 ft. higher than last month, 0.85 ft. lower than a year ago, 1.34 ft. below the average stage of May of the last ten years, 1.79 ft. below the high stage of May, 1894, and 0.11 ft. below the low stage of May, 1879. It will progably rise 0.3 ft. during June.

Lakes Michigan-Huron are 0.26 ft. higher than last month, 0.75 ft. lower than a year ago, 1.16 ft. below the average stage of May of the last ten years, 3.82 ft. below the high stage of May, 1886, and 0.14 ft. above the low stage of May, 1896. They will probably rise 0.2 ft. during June.

Lake Erie is 0.29 ft. higher than last month, 0.70 ft. lower than a year ago, 0.76 ft. below the average stage of May of the last ten years, 2.27 ft. below the high stage of May, 1884, and 0.30 ft. above the low stage of May, 1895. It will probably rise 0.2 ft. during June.

Lake Ontario is 0.16 ft. higher than last month, 0.82 ft. lower than a year ago, 1.13 ft. lower than the average stage of May of the last ten years, 3.05 ft. below the high stage of May, 1886, and 0.60 ft. above the low stage of May, 1895. It will probably rise 0.1 ft. during June.

Iron Ore Shipments

Ore shipments during May were 3,684,819 tons, making the total shipments to June 1 of the present year 4,016,464 tons. This is a decrease of 3,585,201 tons compared with the corresponding period last year, but nevertheless it is better than expected. The June movement will undoubtedly show a respectable increase over May as more vessels have been daily going into commission and the Steel Corporation has begun to charter outside tonnage. While the lake situation is not roseate, it is certainly less discouraging than it appeared two weeks ago. Following are the shipments by ports:

Port.	May, 1910.	May, 1911.
Escanaba	749,091	436,608
Marquette	481,325	204,063
Ashland	588,604	226,528
Superior	955,651	1,239,153
Duluth	2,220,758	896,113
Two Harbors	1,085,929	682,424
	6,081,358	3,684,819
1911 decrease		2,396,539

Port.	To June 1, 1910.	To June 1, 1911.
Escanaba	972,117	529,540
Marquette	616,885	218,931
Ashland	807,307	267,365
Superior	1,310,958	1,315,892
Duluth	2,530,185	947,155
Two Harbors	1,364,213	737,081
	6,081,358	3,684,819
	7,601,665	4,016,464
1911 decrease		3,585,201

Iron Ore Receipts

Receipts of ore at Lake Erie ports during May were 2,633,357 gross tons out of a total shipment of 3,684,819 tons. Conneaut led with 714,453 tons, Ashtabula second with 676,542 tons and Cleveland third with 480,602 tons. The receipts by ports follow:

Port.	May, 1911.
Buffalo	328,241
Erie	27,287
Conneaut	714,453
Ashtabula	676,542
Fairport	86,415
Cleveland	480,602
Lorain	265,417
Huron	12,623
Sandusky	....
Toledo	23,044
Detroit	18,733
Total	2,633,357

Eugene Tyler Chamberlain Resigns

Eugene Tyler Chamberlain, commissioner of navigation, has resigned. Mr. Chamberlain was appointed commissioner of navigation during Mr. Cleveland's first term and has held the office continuously under successive presidents. He has done splendid work during his incumbency of the office and has been a consistent and earnest advocate of the cause of American shipping. His decision to retire is a subject of general regret.

Reward of Careful Navigation

The 1910 insurance policy on the lakes contained the provision that 10 per cent of the earned or net premium would be returned to all vessels that operated during the season without claim upon the underwriters and that one-fourth of the 10 per cent so returned should go to the vessel master. Some owners were reluctant to split the returned premium owing to the fact that the vessel might operate without a claim against the underwriter and yet have damages less than $500, which, under the deductible average clause, would have to be met by the owner. The underwriters, however, have insisted that the master of the vessel shall have his share. It now appears that nearly 50 per cent of the boats enrolled in the Great Lakes Protective Association were operated during 1910 without loss to the underwriters. The association has received returns from the underwriters for 36 vessels up to date. Returns are not made by the underwriters until the policies have expired and the records of the boats examined. The old form of policy held over into the new year and has not yet expired upon a number of vessels and will not for at least 60 days more. However, for the 36 vessels returned by the underwriters, Capt. W. C. Richardson, treasurer of the Great Lakes Protective Association, has mailed checks to the masters of the boats. These checks range from $125 to $350. Many of the vessels were idle during part of the season, which, of course, would reduce the earned premium. The net premium on a steamer of the largest class that operated without claim throughout the entire season will be about $500. The captains who have received checks so far are as follows:

Captain.	Steamer.
J. H. Driscoll	Norway
R. J. Walder	Denmark
C. Z. Montague	Harry Coulby
W. D. Ames	John Dunn Jr.
Wm. McAlpine	J. F. Durston
Alex. Forbes	A. E. Nettleton
George W. Pierce	Lyman C. Smith
John Morrison	Wilbert L. Smith
C. R. Ney	Charles Hubbard
Edward Hough	Charles M. Warner
John Robinson	H. S. Wilkinson
Wm. Heller	A. G. Brower
E. E. Carlton	W. W. Brown
James Watts	Wm. Nottingham
G. W. Honner	B. Lyman Smith
A. R. Beall	Hurlbut W. Smith
George R. Lane	Wm. B. Kerr
J. L. McIntosh	Wm. A. Rogers
J. A. Fleck	Charles Weston
Alex. Johnson	James Corrigan
B. J. Gallagher	D. B. Meacham
George R. Laughlin	Bransford
James Owen	Salt Lake City
S. P. Kinyon	Henry B. Smith
George Robarge	Umbria
J. D. Greene	Wisconsin
Alex. Clarke	Arthur H. Hawgood
C. D. Brown	Henry A. Hawgood
A. C. May	H. B. Hawgood
H. S. Lyons	W. A. Hawgood
W. A. Ashley	J. M. Jenks
L. S. Tilden	Sheldon Parks
O. J. Solean	J. Q. Riddle
W. L. Montgomery	W. R. Woodford
W. R. Neil	S. S. Curry
Wesley Rinn	Abram Stearn

The 1911 policy expires with the season of navigation and no part of the premium will be returned to anyone. The rate of the English underwriter is ¼ of 1 per cent lower than the 1910 rate, though some of the New York underwriters have made a rate of ½ of 1 per cent lower.

Lake Situation

During the month the lake situation has undergone some amendment for the better. While the volume of freight moving is, of course, not as great as that of last year, still it is daily improving. The Pittsburg Steamship Co. has begun to charter outside tonnage and will employ a few vessels from each of the leading fleets. It is not expected, of course, that there will be business for all of the vessels because available tonnage is obviously in excess of the demand, but there will be something to do for all of the fleets if not for all of the vessels. The present situation on the lakes, of course, is one that time will have to remedy. The existing tonnage will have to be digested before there will be work for all the ships to do.

The coal rate to Lake Michigan ports has been cut 5 cents, which was of course to be expected owing to the fact that supply exceeded demand. Vessel owners are hoping for a decided improvement in conditions in the fall.

Obituary

Capt. Thomas Wilford, who was struck with paralysis aboard his steamer, the L. B. Miller, at Lorain, on Saturday, June 3, died at his home on June 5. He was a most successful navigator and his death is generally regretted. He was born at Clipston, Eng., June 21, 1841, and came to the United States with his parents when he was 12 years old. He began sailing in 1859, in sailing vessels, entering the employ of Capt. W. C. Richardson, in 1880. He brought out all the new steamers of the Richardson fleet.

East and West Courses on Lake Huron

IN AN endeavor to minimize the number of accidents occurring in the congested waters of the great lakes, the Great Lakes Protective Association has recommended to its subscribers that east and west courses be observed on Lake Huron and has issued a bulletin to that effect, as follows:

The number of vessels navigating the great lakes has increased so rapidly in the last five years that the rivers and regular routes of travel on Lake Huron and Lake Superior are at times so congested as to greatly intensify the danger of accident by collision, especially in thick and foggy weather.

Four collisions occurred during the season of 1910 along the west shore of Lake Huron, resulting in the loss of 18 lives and approximately $400,000 worth of property.

In considering the question of how the loss from this cause could be minimized, your committee has decided that it would be very desirable for up and down bound vessels to take different courses on Lake Huron, and they strongly recommend that all members of this Association give their masters instructions to use the following courses on Lake Huron:

Up-Bound to Lake Superior.

From Corsica Shoals Lightship—

North	azimuth 5 miles
then N 7/8 W	azimuth 53 miles
then N x W ½ W	azimuth 85½ miles
then NW x N 1/8 N	azimuth 74 miles

to Detour Light.

Up-Bound to Lake Michigan.

From Corsica Shoals Lightship—

North	azimuth 5 miles
then N 7/8 W	azimuth 53 miles
then N x W ½ W	azimuth 85½ miles
then NW x N 1/8 N	azimuth 26½ miles
then NW x W ½ W	azimuth 49½ miles
then West	azimuth 5 miles

to Poe Reef Lightship.

These courses will fetch three miles east of Harbor Beach, seven miles east of Thunder Bay, and seven miles east of Presque Isle Lights. The reason for throwing these courses so far outside Thunder Bay Light is to avoid the shoal spots shown on government chart about seven miles north and a little east of Thunder bay light. These spots show big boulders with 21 ft. of water. At the present height of Lake Huron there is a little less than 21 ft. over these boulders, and they are consequently a dangerous menace to navigation in a heavy sea.

Down-Bound From Lake Superior.

S x E	azimuth 1 mile
then SE ¾ S	azimuth 79 miles
then S x E ½ E	azimuth 87 miles
then South	azimuth 56 miles

to Corsica Shoals Lightship.

Down-Bound From Lake Michigan.

From Poe Reef Lightship—

East	azimuth 5 miles
then E x S ¾ S	azimuth 46 miles
then SE ¾ S	azimuth 36 miles
then S x E ½ E	azimuth 87 miles
then South	azimuth 55 miles

to Corsica Shoals Lightship.

These courses will fetch 13 miles east of Thunder bay light and 11 miles east of Harbor Beach light.

You will, of course, understand that by throwing the down-bound vessels out so far they will in thick and foggy weather probably not be able to locate either Thunder bay or Harbor Beach lights and fog signals, and that in consequence masters will have to be very careful in their navigation. All masters should be cautioned to carefully check up their compasses by the government ranges in the Sault river each down-bound trip, and also to be very careful to check up distances run on each leg of the course. In all cases where they have run out their time within an hour and a half from Corsica shoals lightship and have not been able to accurately locate their positions by whistles of up-bound vessels or other means, they should charge their course to due west until they strike the seven to ten fathoms soundings that are shown on the chart to extend all along the west shore from about five miles above Corsica shoals lightship to Harbor Beach.

Masters are not expected to use these down-bound courses below Thunder Bay light when the wind is heavy from the west or southwest as under these conditions it will be desirable to hold pretty well up into Saginaw bay in order to avoid rolling, but they should be carefully followed under the usual conditions in order that masters may be able to use them with confidence in thick and foggy weather.

We attach hereto chart showing courses described in this letter. These charts should be distributed to your masters.

J. S. ASHLEY,
Chairman.

Submarine Sound Signals

The Submarine Signal Co., of Boston, has equipped over 800 boats with its submarine signalling apparatus. Orders were recently received by the company to equip 16 boats of the Pacific Steam Navigation Co., 13 boats of the Royal Mail Steam Packet Co., four boats of the Compagnie Generale Transatlantique, and nine boats of the North German Lloyd Steamship Co., together with a large number of orders from governments for naval vessels. The larger companies, which have installed the service, include the Pittsburg Steamship Co. with 51 vessels, the North German Lloyd Steamship Co. with 53 boats, the Hamburg-American Line with 30 boats, the White Star Line with 28 boats, and the Canadian Pacific Steamship Co. with 15 boats.

The hydrographic office, some time ago, issued an interesting pamphlet on the subject, particularly with reference to the uncertainty of aerial sound, with which every mariner is familiar. The hydrographic office says:

"Over-sea traffic has exercised a powerful influence upon the advancement of civilization, and the world-wide benefits that flow from counteracting sources of delay and danger in oceanic voyaging have never ceased to prove a stimulus in the search for more definite and accurate aids to navigation. Most of the prominent points of those coasts to which commerce has spread throughout the world are marked with beacons by day and with lights by night, but even if the time should have already arrived, as doubtless it some day will, when all the coasts of the United States had been defined from end to end by a band of light by night and by buoys and beacons, prominently placed, to be seen by day, yet to a mariner encompassed in thick fog all such guides and warnings would be of no avail. Fog obscures the characteristics of the most powerful light and blots out those marks which, when presented to the view, serve to guide and to warn.

"In many parts of the world, especially in the Temperate Zones, fogs frequently occur. On the eastern coasts of the United States and Canada an easterly wind is very often attended with fog. Between the Gulf stream, flowing northward in the Atlantic, and the coast of the continent, a current moves to the southward, bringing to the shores of Canada and the United States water from the Arctic Zone. With an

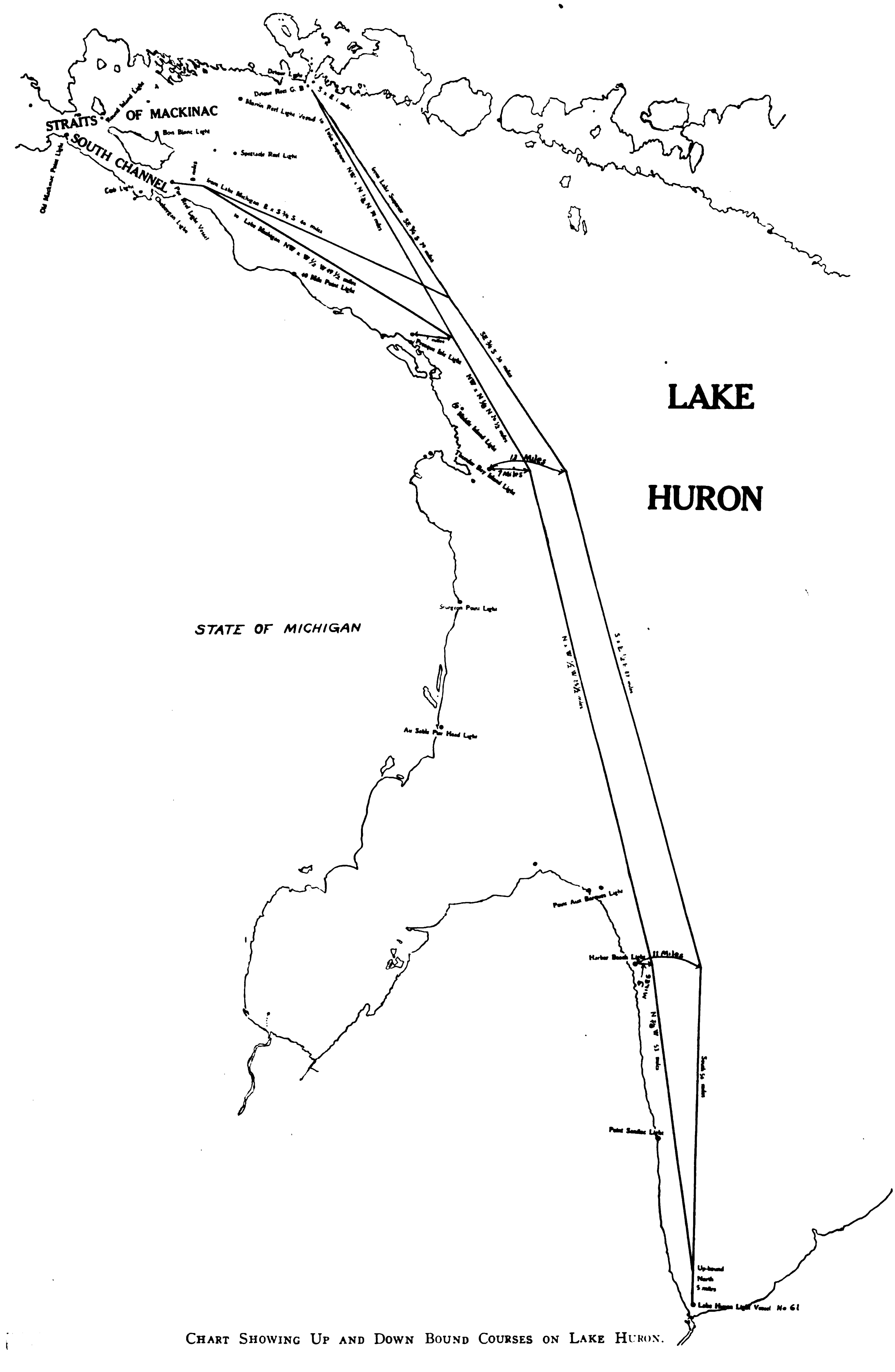


CHART SHOWING UP AND DOWN BOUND COURSES ON LAKE HURON.

easterly wind, air warmed and fully charged with moisture by contact with the Gulf stream, is blown across this cold current and the suspended vapor is chilled and frequently condensed in the form of fog. The embarrassments thus arising to shipping on the coast of America stimulated the people of the United States to be pioneers in the employment of sound signals for combating the adverse influences of foggy weather upon commerce and navigation, for, aside from the possibilities of wireless telegraphy, the sense of hearing is the only means by which human perception may be apprised of the dangers lurking in coastal waters when the sense of sight is unavailable.

"Until recent times, the sound signals generally used to guide mariners, especially during fogs were, with certain modifications, sirens, trumpets, steam whistles, bell boats, bell buoys, whistling buoys, rockets, gongs, bells struck by machinery, and cannons fired by powder or gun cotton. In connection with all these implements the atmosphere is the medium of transmission of the sounds emitted from the sounding apparatus; but it is a characteristic of the air that, in contiguous spaces of the atmosphere, the temperature, humidity, and pressure vary in such a manner as to produce a state which bears the same relation to sound as cloudiness does to light. Tyndall has thus described these conditions: 'By streams of air differently heated, or saturated in different degrees with aqueous vapors, the atmosphere is rendered *flocculent* to sound. *Acoustic clouds*, in fact, are incessantly floating or flying through the air. They have nothing whatever to do with ordinary clouds, fogs, or haze; and the most transparent atmosphere may be filled with them, converting days of extraordinary optical transparency into days of equally extraordinary acoustic opacity.'

The Inadequacy of Aerial Sound Signals.

"The mariner has long since learned to be exceedingly cautious about depending upon aerial sound signals, even when near. Experience has taught him that he should not assume that he is out of hearing distance of the position of the signal station because he fails to hear its sound; that he should not assume that because he hears a fog signal faintly, he is at a great distance from it, nor that he is near because he hears the sound plainly; that he should not assume that he has reached a given point on his course because he hears the fog signal at the same intensity that he did when formerly at that point, neither should he assume that he has not reached this point because he fails to hear the fog signal as loudly as before, or because he does not hear it at all; and that he should not assume that the fog signal has ceased sounding because he fails to hear it, even when within easy earshot.

"While both the range and the certainty of the transmission of sounds through the air may be enhanced by imparting such excessive energy to the sound waves as to render them less liable to the dissipating influences of a variable atmosphere, yet, with the fog signals heretofore in use, it has been impossible to distinguish, by any means available to the mariner at sea, the times when he might expect aberrations in audition from the times when the sounds would be heard normally as to force and place.

The Superiority of Water as a Medium for the Transmission of Sounds at Sea.

"Water is a less mobile medium than air, less responsive to marked variations of density arising through changes in temperature and pressure, and, therefore, less subject to variations of homogeneity and more reliable as an agency of the transmission of sound waves. In his experiments on Lake Geneva, in 1826, Colladon has a bell, weighing about 150 pounds, suspended some 5 feet under water from the side of a boat, and struck by a hammer attached to the end of a lever. Stationed in another boat, he listened for the bell sounds propagated beneath the surface, which were conveyed from the water by a cylindrical tube of tin, some 9 ft. long and 6 in. in diameter. One end of this tube terminated in an orifice for insertion in the ear, and the other was spread out somewhat in the form of a spoon, with its orifice closed by a flat, elliptical plate of tin, about 2 sq. ft. in area. By attaching a suitable weight to the lower end of the tube it was easily retained in a vertical position with about four-fifths of its length submerged, its flat plate being turned toward the boat carrying the bell. With this simple apparatus Colladon was able to hear, with perfect distinctness, the blows of the hammer on the bell across the widest part of Lake Geneva, when the calculated distance between the two boats was not less than eight miles. The sounds which he heard appeared as if they had been caused by some metallic body striking the bottom of the tube, and they were as distinct at eight miles as at a few hundred feet from the bell. One set of observations was made during a strong wind. The waters of the lake, which were at first calm, became violently agitated, and it was necessary to keep the boat in position by means of several anchors, yet, notwithstanding the noise of the waves that struck the tube, he took observations with the same accuracy as when the air and water were still. And he states: 'I am convinced that by employing a bigger bell and improving or enlarging the hearing apparatus easy communication could be effected under the water of a lake or of the sea up to 15 or 20 leagues.'

"Plans for making a practical use of the water as a means of communication between vessels at sea commenced to germinate with the invention of the telephone in the latter part of the last century.

"In his admirable work, entitled 'The Modern Light-House Service', published as Senate Executive Document No. 56, Fifty-first Congress, first session, Mr. Arnold B. Johnson, chief clerk of the United States Light-House Board, has made reference to the experiments which were commenced in 1883 by Prof. Lucien Blake, whose plan he describes as follows: 'A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or at night a code of signals would be produced by it, which would be transmitted in all directions through the water with a velocity four or five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with sound-receiving apparatus, which would take up out of the water the signals arriving from the neighboring vessels. For steamships the sound-producing apparatus was designed to be a steam fog horn or whistle, especially constructed to sound under water and to be heard at least from six to eight miles. * * * As to the receiving apparatus, with which each vessel was to be provided, the original plan of 1883, and which has not been changed, was to employ some form of telephone acting as a transmitter under water and connected with a receiver within the vessel.' * * *

Submarine Signal Bells.

"It is along these general lines that the problem has been so successfully solved under the auspices of the Submarine Signal Co., of Boston, that the method of submarine sound signalling has been officially recognized as supplying an important aid in navigation. As early as 1903, the United States Light-House Establishment had furnished the light-vessels at Boston, Nantucket, Fire Island, and Sandy Hook with submarine fog bells. The equipment consisted of a bell with striking mechanism actuated by compressed air, suspended at a depth of 30 ft. or so beneath the surface of the sea from a davit at the side of the vessel; a small and compact air compressor driven by a kerosene engine or by steam from the boilers of the

light-vessel, for the purpose of furnishing power to operate the bell; and a code ringer also connected with the compressor engine, and adapted automatically to control the strokes of the bell so as to cause its ringing to send out the code number of the light-vessel.

"The sound waves going out from the light-vessels below the surface of the sea could be heard for a distance of some miles by passing ships equipped with microphones to receive submarine sound signals. These sound receivers are located inside of the hulls of ships below the water line, and connected with the chart room or bridge by a telephone circuit. On either side of the forehold there is fitted a small tank on the inside of the skin of the ship, without cutting the plating or making any alteration whatever in the hull of the vessel. A small opening in the top permits the introdution into the tank of a dense liquid in which the receiving microphones are suspended. By listening at the telephone, whose circuit includes both the port and starboard microphones, and switching the instrument from the starboard to the port microphone and back again, the tones of the light-vessel's submarine bell could be heard on coming in range of it. If the tone was louder on the starboard side than on the port, the mariner would know that the light-vessel was on his starboard side, and if the tone was exactly the same in both microphones, he would know that the light-vessel was dead ahead.

"It was found that, even in the case of vessels to which the sound-receiving microphones had not been fitted, a listener, putting his ear to the inner surface of the plating, say in the empty forepeak below the waterline, could hear the sound proceeding from a submarine bell several miles away; but under such circumstances no information is derived as to the direction from which the sound proceeds, and hence a vessel encompassed in fog could not be steered by bell and must suffer a denial of those advantages that come from the knowledge of direction that is derivable on board of vessels in which suitable instruments have been installed to receive the sounds.

"The substantial service rendered to shipping by the submarine bells first established decided the United States Light-House Board to extend their installation, from time to time, to other light-vessels until, at present, 46 of the light-vessels in the waters of the United States are thus equipped and the signals which they send out are of undoubted aid to deep-water navigation.

"Equally effective as aids to navigation are the submarine bells that have been fitted to buoys, where they are worked by the motion of the sea, and those that have been suspended from tripods on the sea bottom, where they are controlled electrically from shore stations and serve to give warning of dangers or to mark turning points along the routes of commerce.

"Many of the light-vessels and buoys in European waters have been similarly furnished with these bells, and they have been likewise established in the region of the Gulf of St. Lawrence; and, as the effective range of the submarine bell far exceeds that of aerial sound signals, having been known to exceed 15 miles, and their bearing can be determined with sufficient accuracy for safe navigation in fog, if a vessel is equipped with receivers, it has seemed appropriate to set forth for the benefit of mariners a list of the stations where they are at present established.

"Remarkable endurance tests have been applied to some of these submarine signaling installations. From a cottage at Point Allerton, near Boston, in which a 2½-h. p. oil engine operated an electric generator, a submarine cable was laid to the shore, and thence two miles out into the harbor along the sea bottom. At the end of the cable was an iron tripod standing on the bottom of the ocean, 70 ft. below the surface of the water, and on the tripod was a bell weighing 220 lbs., the clapper of which was actuated by powerful magnets. On March 30, 1907, the current was turned on and the bell began to strike at the rate of about 22 blows a minute, and continued until May 16, when the total number of strokes had reached 1,032,930 in a duration of 789½ hours.

"The pneumatic bells on five light-vessels were also required to be rung continuously, night and day, for 61 days, making a period equal to two and a half years of service according to the highest demands made in past years upon the fog whistle on the light-vessel at Sandy Hook. Submarine bell buoys have also been tested. The fact that the bearing of the buoy can be found in fog or at night makes them advantageous to shipping when they are placed in exposed positions in water of sufficient depth to give the vessels steering for them sufficient space to maneuver for the purpose of locating the origin of the sound. It is noted that in restricted waters, or when the bell is located near steep banks or rocky shores, an echo may be expected; and this fact requires that the proposed location should, in each case, be thoroughly investigated by experiment, because there are possible situations where the echo may be heard instead of the direct sound, and thus lead to an erroneous determination of the place of the danger which the bell is intended to mark.

"The mechanism for submarine bell buoys is dependent on wave motion for its power, and, therefore, differs from that of the electrically-controlled tripod bell and also from the pneumatic bell employed in connection with light-vessels. On the trunk or stem of the buoy is a float or 'sea anchor', free to move up and down for a short distance and ballasted so as to have, as nearly as may be, the same weight as sea water. It is the design that this shall remain practically stationary as the buoy rises and falls. The pull rod of the clapper is connected to a crank on a toothed wheel which is turned by a ratchet-and-pawl gear, operated by two arms attached to the sea anchor. Of special interest in connection with submarine-signal buoys are the gas buoys which have been experimentally fitted with bells that are rung through mechanism actuated by the pressure of the gas supplied for the light, and are thus independent of the action of the waves as an agency for ringing the bell, and consequently free of the liability to irregularity in the intervals between the strokes of the clapper, which precludes the successful ringing of a code signal.

Communication Between Vessels at Sea.

"Beside their usefulness in warning vessels of their approach to the land and to dangers, submarine sound signals may be used as a means of communication between vessels at sea. For this purpose the sound-producing bell, immersed in water held in a tank, is installed, in the forepeak of the vessel, inside of the hull, and may be operated automatically or by hand. As a means of communication between submarine boats in a state of submergence, this method of signaling has a special field of utility. During the tests of submarine boats in May, 1907, communication was, in this manner, kept up between the Octopus and the tender Starling. Signals were communicated from the Starling to the Octopus, telling when the latter had crossed the finish lines and when to come to the surface, and distinct messages were received in return from the submerged vessel.

The Equipping of Vessels with Submarine Sound Receivers

"The maritime community has availed itself more and more of the facilities which have thus been provided by the fostering care of the various governments with a view of lessening danger in navigation and delay in transportation, and an increasing number of vessels have, year by year, been furnished with submarine sound receivers, and, for the convenience of underwriters in determining rates of insurance, the American Bureau of Shipping has noted

in 'The Record of American and Foreign Shipping', which of the vessels are so equipped.

"The saving of time brought about by enabling vessels to reach port instead of being delayed by fog and losing tides is being constantly exemplified. The Lucania, while approaching New York on one occasion, made all three light-vessels by submarine-bell sounds, which constituted the sole guide; and we read in the *Cologne Gazette* that the captain of the Kaiser Wilhelm der Grosse during the course of a voyage to New York, when surrounded by a dense fog off the coast near Fire Island light-vessel, heard the submarine bell and was able to steer by it, when, as it subsequently transpired, he was 12 nautical miles distant from the signal station. At 6:45 a. m., the sound of the bell was heard to starboard, and, owing to the fog, the ship, which was some distance out of her position, was guided solely by these bell signals, and the course was altered by the sounds heard from the lightship, though the fog horn was wholly inaudible.

The Range of Audibility of Submarine Bells.

"While careful listening at the telephone is always a requirement that must not be underrated nor overlooked, it is found that vessels of deep immersion have an advantage in the range of distance at which submarine sound signals may be detected, and this is accentuated in cases where they are moving at a slow rate of speed. Indeed, on the Great Lakes, where the forepeaks of vessels are frequently above the waterline, special provision was necessary for the proper submergence of the tanks containing the sound receivers.

"There appears to be no failure to hear and recognize the sound of the submarine signal bells at distances between three and five miles, and on the average these distances are considerably exceeded.

"What range of submarine transmission of sound waves will ultimately be set as the limit of practical audibility of such signal bells is not now known, but the possibility of a comparatively extended range, under special conditions, is foreshadowed in the observations that have been lately made between the light-vessel Gabelsflasch, located at the entrance to Kiel, Germany, and the light-vessel Fehmarnbelt, situated nearly 27 nautical miles away. On different occasions the ringing of the submarine bell on the latter light-vessel was heard by the unaided ear through the naked walls of the carpenter's store-room on the Gabelsflasch vessel. Without doubt this remarkable transmission was favored by the form of the sea bottom, which, while not of an even depth in the region between the light-vessels, does not suffer any sudden or great irregularities; and, perhaps, the energy of the sound waves, freed of interference by the infrequency of traffic in midwinter and by the absence of agitation of the waters from storm, was conserved and strengthened by the narrowing shape of the borders of this portion of the German sea.

"Although there are some situations in which the submarine sound signals are cut off, as, for example, when an underwater formation, like a bank or shoal, rises from the bottom and culminates near the surface of the sea, these observations on the Gabelsflasch vessel indicate that conditions may be found or arranged which will be exceptionally favorable for the distant transmission of signals. Thus, where there is a funnel-shaped entrance bounded by jetties running far out into the sea, it may be practicable, by the concentration of waves from an origin of sound placed near the vertex of the funnel, to mark out a sharply defined sound sector for the purpose of locating the entrance when it is obscured from view by fog or darkness."

Submarine Boat Skipjack

The submarine boat Skipjack was launched from the yard of the Fore River Ship Building Co., May 27. The boat is 135 ft. long and 14 ft. beam, and is driven by two 115-horsepower motors.

The Great Lakes Engineering Works has delivered at Ashtabula the 180-ton steel pontoon gate for its new dry dock at that port.

Commerce of Lake Superior

During May 6,125,018 tons of freight passed through the canals at Sault Ste. Marie. The movement to June 1 was 6,917,605 tons as against 10,487,199 tons to June 1 last year, a decrease of 3,569,594 tons. The summary follows:

	To June 1, 1910.	To June 1, 1911.
EASTBOUND.		
Copper, net tons	22,202	21,405
Building stone, net tons	....	612
Grain, other than wheat, bu.	11,235,276	7,445,191
Flour, bbls.	1,261,958	1,035,137
Iron ore, net tons	6,992,650	3,585,990
Iron, pig, net tons	3,706	7,598
Lumber, M. ft. B. M.	99,301	80,431
Wheat, bu.	18,317,844	17,392,591
Unclassified freight, net tons	18,823	11,773
Passengers, number	1,605	1,921
WESTBOUND.		
Coal, anthracite, net tons	467,042	266,822
Coal, bituminous, net tons	1,579,224	1,792,324
Flour, bbls.	1,000	125
Grain, bu.	100	....
Manufactured iron, net tons	50,997	77,007
Iron ore, net tons	....	3,130
Salt, bbls.	159,143	175,815
Unclassified freight, net tons	231,494	220,792
Passengers, number	2,204	2,790
SUMMARY OF TOTAL MOVEMENT.		
Eastbound, net tons	8,095,083	4,531,433
Westbound, net tons	2,392,116	2,386,172
Total	10,487,199	6,917,605
Vessel passages	3,626	2,641
Registered tonnage, net	9,044,088	5,609,857

Ship Yard Note

The Staten Island Ship Building Co., Port Richmond, launched the three-masted schooner Katrina recently, the largest pleasure sailing craft ever built in the United States. The yacht is 198 ft. over all, 150 ft. on the water line, 33 ft. 8½ in. beam, with a draught of 17 ft.

LAUNCH OF SUBMARINE BOAT SKIPJACK.

ACCIDENTS TO LAKE VESSELS

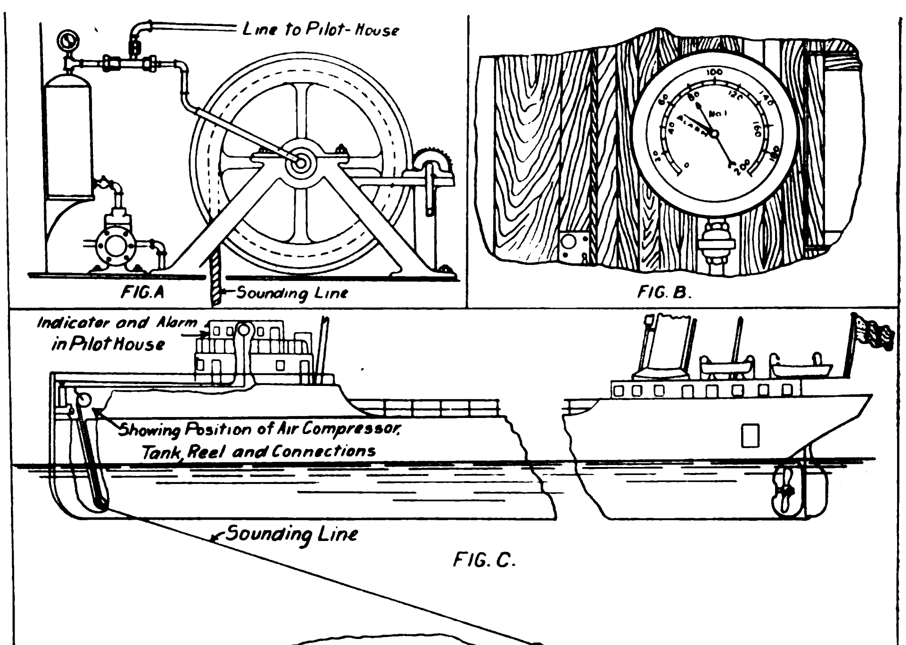
Accidents on the lakes have unfortunately been numerous since the season opened. The total losses have been four and the number of lives lost 15. The most serious loss was that of the steamer Erwin L. Fisher, which was sunk in collision with the steamer S. M. Clement in the Detroit river through a misunderstanding of signals. Strandings have been frequent and fire seems to take its usual quota. Deranged steering gear and the parting of wheel chains is also well up in the list of causes. The accidents tabulated follow:

DATE.	NAME OF VESSEL.	NATURE OF ACCIDENT.	PLACE.
Jan. 10	Fish tug Effie B.	Sprang leak while lying at dock; pumped out and leak patched up..	Cleveland.
Jan. 30	Str. Mary C. Elphicke	Large hole torn in her side by explosion of nitroglycerine near place where she was anchored	Erie, Pa.
Jan. 31	Tug R. P. Tomlinson Jr.	Sank at dock	Port Huron, Mich.
Mar. 15	Fish tug Silver Spray	Sank in storm; seven lives lost; tug raised May 27	Outside Cleveland breakwater.
Mar. 16	Str. Portland	Pounded against str. Sultana in storm while moored alongside her; repaired at Ecorse; four plates taken out and six repaired in place	Cleveland.
Mar. 16	Str. Sultana	Struck by str. Portland; number of plates and frames damaged; also $1,500 loss by fire; repaired at Cleveland	Cleveland.
Mar. 16	Str. Alexis W. Thompson	Parted all her mooring lines in storm; deck engine damaged	Cleveland.
Mar. 16	Str. H. S. Wilkinson	Two mooring cables torn by storm and in swinging around she struck str. J. L. Weeks; docked at Cleveland for repairs April 11	Buffalo.
Mar. 16	Str. Abraham Stearn	Damaged to extent of $7,000 when Milwaukee-Western Fuel Co.'s dock was dynamited; part of unloading rig fell on steamer, damaging decks, hatches, arches and side plating	Milwaukee.
Mar. 26	Str. Cataract	Damaged by fire; loss about $4,000	Brockville, Ont.
April 6	Oil barge No. 41	Struck by Main avenue bridge; smokestack, flag pole, side lights, life boat and life raft carried away; hull not damaged	Cleveland.
April 13	Sch. Ottawa	Wrecked; total loss; five lives lost; value—vessel, $2,000; lumber cargo, $2,500	Near Sturgeon Bay, Lake Michigan.
April 19	Str. North Star	Broke two buckets off her wheel in heavy ice; towed to Cleveland for repairs	
April 23	Str. North Lake	Collided with str. John Lambert in heavy sea; bow damaged; repaired at Buffalo	Point Abino, Lake Ontario.
April 23	Str. John Lambert	Collided with str. North Lake in heavy ice; port anchor carried away and seams sprung; vessel beached to prevent sinking; seams calked with bags and temporarily repaired at Sault	Soo.
April 25	Tug James Edwards	Engine disabled; docked at Cleveland for shaft repairs; also new wheel	Soo.
———	Str. H. H. Rogers	Detained 12 hours at Sault to make repairs to broken propeller....	Near Ashtabula, Lake Erie.
April 27	Str. Ontario	Got stuck in Erie railroad draw; had to lighter 2,000 tons and lost a whole day through accident	....
April 28	Str. Geo. C. Crawford	Stuck in Northwestern railway draw; released herself on April 30, apparently uninjured	Cleveland.
April 29	Str. Simla	Ran aground on mud bottom; lightered 300 tons and proceeded on trip, uninjured	Milwaukee.
May 1	Sch. Kate Howard	Capsized in storm; crew had very narrow escape, but were picked up by str. Sir Henry Bessemer; wreck sold at Milwaukee on June 1 for $8	Round Island, Lake Superior.
May 1	Str. Crescent City	Stranded in storm; released after jettisoning part of coal cargo; forward compartment leaked; docked at Cleveland; six damaged plates	Port Washington, Lake Michigan.
May 1	Str. John Stanton	Struck Round Island in storm; No. 1 tank on port side punctured, causing bad leak; to be docked at Lorain; will lose one trip through accident	Big Summer Reef, Lake Michigan.
May 2	Str. J. J. H. Brown	Clogged her wheel chains and ran hard aground; lightered 700 tons and was released May 4; docked at Buffalo, May 24; 20 plates damaged; 10 days to make repairs	Round Island, St. Mary's river.
May 3	Str. Scottish Hero	Struck at entrance to harbor and was quite badly damaged; probably will be docked at Collingwood	Limekiln Crossing, Detroit river.
May 5	Str. Alva	Ran into tug Boynton through misunderstanding of signals and then into Great Lakes dock, damaging it somewhat	Midland harbor.
May 5	Tug Boynton	Hit by str. Alva; stern bearings damaged and 40 ft. of rail strake ripped off	Soo.
May 5	Str. Erwin L. Fisher	Collided with Str. Stephen M. Clement through misunderstanding of signals; sank almost immediately; three lives lost; abandoned by owners to underwriters as constructive total loss....	Soo.
May 5	Str. Stephen M. Clement	Collided with str. Erwin L. Fisher; bow damaged; to be repaired at Buffalo	Detroit river.
May 5	Str. Ontario	Ran aground in Waukegan harbor; released, uninjured	Detroit river.
———	Str. Glenmount	Stranded; on several days; released, slightly injured	Waukegan, Ill.
May 5	City of Hamilton	Stranded; released by wrecker Favorite, uninjured	Near Oak Point, St. Lawrence river. Synicardy river (Canadian side).
May 8	Str. Donnacona	Collided with stone wall near Roney's Bend, causing bad leak; towed back to Port Colborne to unload; grain cargo badly damaged; docked at Buffalo, May 12	Near Point Colborne, Lake Erie.
May 8	Str. I. W. Nicholas	Ran aground with cargo of coal; released on May 10, leaking badly; equipped with air compressors and proceeded to Duluth where she was repaired; ragged hole 5 ft. long and 1 ft. wide on starboard side just forward of collision bulkhead; hit by str. Morse just as she was about to leave with temporary repairs, demolishing cement patch	Carp Island, near Detour, Sault river.
May 8	Tug Saugatuck	Damaged by fire; loss, $500	Buffalo.
May 10	Str. Major	Damaged by fire	Chicago.
May 16	Str. Caledonia	Ran aground; released, uninjured	Southeast shoal, Lake Erie.
May 16	Bge. S. D. Thomas	Ran aground; lightered several hundred tons and was released on May 17	Sault river.
———	Bge. S. O. No. 86	Docked at Cleveland, May 16, for damage sustained in coming through canal; left dry dock May 26	Welland canal.
May 17	Str. Wilpen	Wheel chains parted and she ran aground; released by tug without lightering; not damaged	Limekiln Crossing, Detroit river.
———	Str. W. H. Gratwick	Arrived at Milwaukee with all buckets stripped off her wheel......	....
———	Sch. Shawnee	Sank to bottom; vessel badly twisted	Near entrance Cleveland harbor.
May 18	Str. Emperor	Broke her shaft; picked up by str. Superior and towed to Sault; to be repaired at Collingwood	Thunder bay, Lake Huron.
May 20	Str. St. Clair	Stuck in Erie railroad draw; not damaged but lost a day	Cleveland.
May 20	Str. Wm. P. Palmer	Ran on bank in strong current; released and docked at Lorain; three damaged plates	Detroit river.
May 21	Str. Joshua Rhodes	Steering gear broke and rudder damaged; towed to Detroit by tug and then to Cleveland by str. Francis L. Robins and tug; docked May 25; extensive repairs, including new wheel, shoe and rudder and repairs to stern frame	Above Algonac, St. Clair river.

DATE.	NAME OF VESSEL.	NATURE OF ACCIDENT.	PLACE.
May 21	Str. Choctaw	Ran aground in heavy fog; released, slightly damaged	Near Corsica shoal.
May 21	Str. Daniel B. Meacham	Struck obstruction while going up; bow punctured; leaked; docked at Lorain, May 31	Sailors' Encampment, St. Mary's river.
May 21	Str. Andrew Upson	Ran aground	Head of Russell Island, St. Clair river.
——	Str. Joliet	Broke her low pressure valve stem	....
May 21	Bge. Edward Kelly	Ran aground; released after jettisoning 60 tons of coal	Near Port Dalhousie, Lake Ontario.
——	Str. Empire City	Stopped at Cleveland, May 22, for repairs to her steering gear	....
——	Str. W. A. Paine	Struck; docked at Lorain, May 25, for repairs	Lake St. Clair.
——	Str. Maricopa	Collided with bge. 137; repaired at Cleveland; four plates on port quarter damaged	Two Harbors, Lake Superior.
——	Str. Ionic	Struck; docked at Montreal for repairs, May 25	St. Lawrence river.
May 24	Str. Turret Cape	Struck; released on May 25 after lightering about 100 lb. of cement	Round Island, St. Marys river.
May 25	Str. Beaverton	Struck hard in fog; leaked but pumps kept her clear and she proceeded	Passage Island, Lake Superior.
——	Str. M. T. Greene	Struck shoal; released after lightering; wheel broken, forefoot smashed and one spar carried away; to be repaired at Collingwood	Near Devil Island, Lake Huron.
——	Str. City of London	Ran ashore; released on May 29 after lightering 600 tons of coal	False Presque Isle, Lake Huron.
May 26	Str. Thos. Cranage	Ran aground	Point Edward, St. Clair river.
May 27	Bge. Plymouth	Ran hard aground on east bank; lightered 145,000 ft. of lumber; released May 29	Strawberry Island, Niagara river.
May 29	Str. City of Kalamazoo	Damaged by fire; loss, $2,000	South Haven, Mich.
May 31	Str. A. E. Nettleton	Dragged her anchor during storm and ran hard aground; tanks full of water	Erie, Pa.

Shallow Water Alarm

The "Shallow Water Alarm" is a sounding line which hangs from a vessel and shows the depth of water under her keel, when the depth is not greater than the length of the line. When the vessel is moving with a maximum speed of not more than 12 miles per hour, the line, as at present constructed, drags at a depth of about 60 feet; if the speed is less, the line drags deeper. When the depth is less than 60 ft., it is shown exactly, and at every instant of time. When the depth is more than 60 ft., the line shows 60 ft. with no bottom. When installed on a vessel, the depth is shown on a gage in the pilot house. When the vessel is running at 12 miles an hour in deep water, only 60 ft. is shown; if the vessel is stopped, a 300-ft. sounding is made. There is an electric alarm attached to the gage, which may be set to ring at any desired depth. For example: When the vessel is going through deep water and the line is showing 60 ft. and no bottom, the pilot may set the alarm at any depth he chooses, say at 40 ft.; when the vessel gets into 40 ft. of water, the alarm will ring and attract the pilot's attention. If desired, a second alarm may be placed in the captain's room as a tell tale, so that the vessel cannot get into shallow water without its being known. The shallow water alarm will do these things automatically and certainly, it will never be careless or inattentive.



DETAIL DRAWING OF THE APPARATUS.

The line, as at present constructed, is a rubber hose, 300 ft. long, and having a ½-inch bore. It is covered with wire armor, which gives it a tensile strength of about 10 tons. The lower half of the line is covered with chilled iron rings that prevent wearing when the line drags on the bottom. The line weighs about 600 lbs. A stream of air is forced through the hose, coming out in bubbles at the lower end. The pressure necessary to force the air through the hose varies directly with the depth of the lower end of the line. That is, a pressure of 1 lb. is required to force air through the line when its lower end is 2.31 ft. under water; if the depth be doubled, so as to be 4.62 ft. under water, the pressure will also be doubled, so as to be 2 lbs., and this ratio is true for any depth. So if the pressure in pounds be multiplied by 2.31, it will give the depth in feet. In use it is found convenient to have the gage marked in feet so that it shows the depth directly. The details of the entire apparatus are shown on the accompanying drawing. The methods of its use and some of its advantages are as follows:

First.—The instrument will *indicate in the pilot house while the vessel is traveling at the rate of 10 to 12 miles per hour,* a depth sufficient to make it safe and give warning, should the water become too shallow for safe navigation.

Second.—A glance at the indicator in the pilot house is all that is necessary to note the continually changing depth as the vessel passes over the bottom, not an occasional depth that is some distance behind when it is found, but one continuous line of soundings, which are given at the time they are taken.

Third.—The instrument is under cover and there is no need of any part of the vessel's crew being exposed in rough weather or during storms.

Fourth.—The operation is entirely automatic and does not depend on the accuracy of the operator.

The accompanying blueprint will give a clear understanding of the principles and method used in securing these results.

Fig. *A* shows an air-compressor, air-tank with gage attached, air connections and reel used in handling the

SUMMARY OF NAVAL CONSTRUCTION.

Name of Vessel.	Building at.	Per cent of completion. 1911. Apr. 1.	May 1.
BATTLESHIPS.			
Florida	**Navy Yard, New York**	91.4	92.7
Utah	**New York S. B. Co.**	97.5	98.0
Wyoming	**Wm. Cramp & Sons**	56.8	61.5
Arkansas	**New York S. B. Co.**	63.3	64.7
Texas	**Newport News S. B. Co**	4.6	9.3
New York	Navy Yard, New York	0.0	0.0
TORPEDO BOAT DESTROYERS.			
Mayrant	**Wm. Cramp & Sons**	96.5	96.5
Monaghan	**Newport News S. B. Co.**	84.5	91.5
Walke	**Fore River S. B. Co.**	91.1	97.8
Ammen	**New York S. B. Co.**	95.5	99.2
Patterson	**Wm. Cramp & Sons**	72.8	78.3
Fanning	Newport News S. B. Co	9.3	15.3
Jarvis	New York S. B. Co	8.1	8.7
Henley	Fore River S. B. Co	8.4	10.0
Beale	Wm. Cramp & Sons	6.8	11.8
Jouett	Bath Iron Works	11.8	19.6
Jenkins	Bath Iron Works	10.7	17.9
SUBMARINE TORPEDO BOATS.			
Carp	Union Iron **Works**	85.1	87.7
Barracuda	Union Iron **Works**	85.1	87.9
Pickerel	The Moran Co.	79.5	84.2
Skate	The Moran Co.	79.5	84.4
Skipjack	**Fore River S. B. Co.**	83.8	85.8
Sturgeon	**Fore River S. B. Co.**	82.6	85.0
Thrasher	**Wm. Cramp & Sons**	35.5	38.8
Tuna	**Newport News S. B. Co.**	59.6	73.1
Seal	**Newport News S. B. Co.**	85.4	86.2
Seawolf	Union Iron Works	19.4	23.8
Nautilus	Union Iron Works	19.1	23.8
Garfish	The Moran Co.	16.0	21.8
Turbot	Lake T. B. Co.	5.4	11.5
COLLIERS.			
Neptune	**Maryland Steel Co.**	86.5	90.6

sounding-line. The sounding-line is a rubber hose, 300 ft. long, around which there is a woven wire cable with a tensile strength of 10 tons. The line is, to all outward appearance, a wire rope.

Fig. *B* shows the indicating gage and alarm in the pilot house of the vessel.

Fig. *C* shows the manner of installing the various parts.

When it is desired to operate the instrument, the air-compressor is started and maintains a constant pressure in the tank. The pressure necessary depends upon the depth to which it is desired to sound, but may be any pressure within the capacity of the air tank without changing the accuracy of the instrument. If a pressure of 80 lbs. is maintained, the instrument will record any depth from 100 to 184 ft., or 2.31 ft. for each pound of air in the tank. The air passes from the tank through the connections to the indicator or gage and through the sounding line continuously. As the end of the line descends in the water, the pressure required to force the air out of it increases and this pressure is recorded on the gage indicator in the pilot house in feet. The vessel traveling along at its regular speed will allow the line to drag at a certain depth; if at any time the indicator shows less, it is certain that the line is dragging on the bottom. To make certain that it will be known when the vessel is approaching shallow water without continually watching the gage, there is an electric alarm attached. The working of this alarm is entirely separate from the sounding device and may be set to give an alarm at any depth less than that which the gage is recording. After the vessel passes into any depth less than that which the speed of the vessel will lift the line, there is an accurate record of depth in the pilot house given at the same instant it is taken.

During the past seven years, the instrument has been passing through the various steps to perfection. For the past five years it has been used in connection with the river and harbor improvements as an automatic sounding and recording device, known as the bathometer. It was only during the past season (1910) that the same principle has been tried on two of the lake freighters of the Northern Lakes Steamship Co. as a shallow water alarm. The first trial was on board the steamer Champlain, sailed by Capt. Fred A. Dupuy, on that steamer's first trip up the lakes. In this case the line was held at the bow and allowed to drag from the surface of the water and in this way, traveling at the usual rate of speed, the instrument recorded approximately 30 ft. of water and worked satisfactorily at that depth. The second trial was on the steamer Ste. Claire, sailed by Capt. George Trimble. In this case the same method was used to hold the line at the surface of the water near the bow. A longer and heavier sounding-line was used than in the first case. On the way up the lake, when near the St. Clair Flats Canal, the end of the line was placed overboard in about 20 ft. of water and from this time to the time of the vessel passing into deep water in Lake Huron, there was a correct record of the depth of water under the vessel indicated in the pilot house. The greatest depth recorded was 57 ft. After passing into deep water, the alarm was set at 40 ft. and the first alarm was sounded when passing over the Thunder Bay Island Shoal. The same instrument, properly installed in a loaded vessel going at a speed of 11 miles per hour, would show a depth of 75 ft. from the surface of the water.

Around the Great Lakes

Contractors building the upper approach for the Livingstone Channel in the Detroit river complain that they are much hindered in their operations by the failure of passing freighters to proceed under check. The Lake Carriers' Association asked the Dominion government to station a patrol boat at the point to regulate the traffic, but this the Dominion government refused to do and other arrangements will accordingly be made.

Vessels are having considerable trouble in the Detroit river in the vicinity of Ballard's Reef, as a large part of the channel is being taken up by the dredging outfits. On a few occasions collisions have scarcely been averted and President Livingstone of the Lake Carriers' Association has held consultations with vessel owners for the purpose of making definite arrangements for handling vessels at this point.

The first train load of ore from the Cayuna range to the new Soo Line docks at Superior, Wis., was received on May 5. The load consisted of 50 cars or 3,500 tons and the ore came from the Kennedy mine.